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LAKE SPAULDING—DRUM POWER DEVELOPMENT.

BY R. W. VAN NORDEN

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BY R. GUILLON

PUBLIC UTILITY ACCOUNTING IN OREGON



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# LAKE SPAULDING—DRUM POWER DEVELOPMENT

BY RUDOLPH W. VAN NORDEN.

(The subject presented covers the largest hydroelectric development on a single water-shed on the Pacific Coast. It is particularly interesting from the fact that the entire run-off of this water-shed is conserved and used for power seven times, having an aggregate vertical fall of five thousand feet. After leaving the last power plant, the water is used for irrigating over seventy thousand acres of deciduous fruit lands. It is probably the most complete exploitation of a water-shed to be found. The article was written and presented before the San Francisco Section of the American Institute of Electrical Engineers by Rudolph W. Van Norden, Fellow A. I. E. E., Member A. S. C. E.—The Editors.)

There is probably at no place in the world, an example of the total economic use of a watershed more completely exemplified than in the new project of the Pacific Gas & Electric Company, known as the Lake Spaulding-Drum development. A characteristic of California water powers is the high mountain storage of the winter flood waters, to be used during about one-third of the year when the natural runoff becomes a minimum. A second feature found in Western plants is the rapid fall of the rivers, which makes possible a short canal to supply the power plant, together with a high head, as a result of the topography of the country. Both of these features predominate to a marked degree in the South Yuba development.

The new Lake Spaulding development embraces the entire watershed of the South Fork of the Yuba River, above Lake Spaulding; it is the final and complete utilization of this watershed.

The history of the development of these early reservoirs is extremely interesting and forms an important part of the early history of California. For many years the storage system, which embraces the upper reaches of the South Yuba River, was owned by the South Yuba Water Company. This system, by purchase and by construction, from year to year, had acquired up to 1900, twenty-two storage reservoirs with a total capacity of over 1,020,000 miners' inches, which is equivalent to 2,200,000,000 cu. ft. of water.

The area of the South Yuba watershed above Lake Spaulding is 121 square miles. The annual average precipitation over the watershed will vary from forty-three to ninety-five inches. The runoff averages 0.74 of the precipitation. That this variation is marked, enters largely into the economic study of water supply from this source.

The runoff from the watershed varies from 475,-

The Drum Canal About One Mile Below the Outlet Tunnel From the Lake Spaulding Dam.

000 acre feet which occurred in the season 1906-07 to a minimum of 195,000 acre feet which occurred in the season 1911-12. The total capacity of the South Yuba reservoirs was never at any time sufficient to collect more than one-quarter of the runoff, while in years of heavy runoff, over 9 times the capacity of these reservoirs has wasted.

In the year 1905 the property of the South Yuba Water Company and its subsidiary company, the Central California Electric Company, was absorbed by the Pacific Gas & Electric Company. The enormous potential possibilities of the watershed and the topographical aspect of the country which lies below the watershed, for power purposes, and for irrigation were forseen. The site for the new Lake Spaulding dam was selected in 1905 by F. G. Baum and surveyed in 1906 under the direction of J. H. Wise. At this time the physical condition of the South Yuba Company was not of the best and in order to maintain the service requirements which many years of business in supplying water had developed, it was necessary to reconstruct many of the dams, flumes and ditches of the system. Much of this work was under the supervision of the late James H. Wise, who was hydraulic engineer of the company. While Mr. Baum and Mr. Wise familiarized themselves with the physical details of this system, they foresaw the immense potential possibilities, developed a plan for a project which would form the backbone of the already extensive hydroelectric system then in operation. The problem resolved itself into a feasible plan to conserve all of the water which was being wasted during a minimum year. The remainder of the problem of developing power with this water became a simple matter, as nature had provided short distances, heavy falls and the land for cultivation, which could be irrigated by this surplus water.

The Pacific Gas & Electric Company, have, outside of this new development and outside of the watershed, five hydroelectric plants in operation, with three additional, dependent upon this watershed. These plants are on four distinct and separate systems and watersheds; the most northerly being a distance of 120 miles from the most southerly. The amount of power represented in installed machinery in these plants is 77,000 h.p. The system of network which is supplied from these plants has a total line (not circuit) mileage of 1215.8 miles. It covers an area in the central and most populous part of the state of California of 11,800 square miles, which includes the metropolitan district of San Francisco and the east bay cities.

The new Lake Spaulding development is situated about midway with respect to the other power developments.

The amount of average power which will be developed by the new system is nearly three times the total amount of power which has heretofore been developed by all of the other plants. The network to be used and the area to be served by this additional supply of power is identical with that which is being served. It can be readily seen that a problem in the study of power plant economics of the highest order has presented itself here. This study is the complete and most efficient exploration of a watershed. A study of the design of power plants was required, which should not only avail the use of this watershed to its utmost efficiency, but would also serve this system in such a way, that its power will form an economic addition to that which is being supplied from other plants. In other words, that its load factor shall be such as to improve the load factor of other plants and of the system in general, without depreciating its own value as a power producing medium. In order to determine the design for these economic results, it is necessary to thoroughly understand the methods in use in supplying power, the physical, political and municipal restrictions which are present and which must be considered, the existence of present investment and the final economic cost with respect to the results to be obtained.

This entire problem was made a study for some five years by Mr. Wise in which Mr. Baum associated with Mr. Wise, as consulting engineer for the company, collaborated. The decision to begin the development of this project was made in June, 1912, and actual work commenced on July 1, 1912. Some preliminary work, such as surveys and reports had been previously made, but this was to obtain information to enable the company to decide as to feasibility and possibility of carrying forward, so large a project.

### Outline of Project.

The development commences at the Lake Spaulding reservoir. This was originally one of the later reservoirs of the old South Yuba Water Company. It was completed in 1892 by John Spaulding, the general superintendent of the South Yuba Water Company and who is more than anybody else identified with the development of that system. (See map page 540.)

This lake has a dam 65 ft. high, of the rock filled type, a fine example of early California practice. The lake is about 9 miles long and very nearly as wide and a capacity of about 270,000,000 cu. ft. It occupies a valley where the banks of the South Yuba spread out and originally formed a meadow. It is situated immediately below the junction of the South Yuba and Fordyce Creek and is the lowest in altitude of the storage reservoirs of the system. Its altitude is 4,880 ft. The flow from the other reservoirs is received, in this lake, on its way to the points of use. Below the old Lake Spaulding dam, the banks of the South Yuba narrow to form a deep gorge or box canyon. This has always been one of the scenic points for this section of California. Within this gorge is a small diverting dam which has, in the past, diverted the flow from the entire storage system into a flume. It is built on a shelf blasted out from the almost vertical cliff of the gorge. This flume is described in some of the earlier accounts of California's industrial progress as being "one of the greatest feats in existence." In the day that it was built, such a statement may have been quite justifiable and even now, one wonders at the temerity of the pioneer miners in accomplishing so substantial a piece of work.

Near the upper end of this gorge and above the diverting dam just mentioned, is an ideal site for a high dam, and here is the key note of the entire development which has taken place. By building a

dam at this point to a height of 305 ft., it is possible to increase the depth, not only of the old Lake Spaulding reservoir, but also of making storage between the old dam and the new dam, so that a capacity of storage of 4,000,000,000 cu. ft. may be had. This additional capacity doubles the available storage of the old system and makes it possible to store all of the flood waters from this watershed in a minimum year.

The present draught of water from the system outside of the use of water for the new Drum plant is about 175 cu. ft. per second for average years. It is possible with the use of the additional storage, to increase this draught in a year of minimum flow to 270 cu. ft. per second, or in average years to 350 cu. ft. per second and in a maximum year to 400 cu. ft. per second. With this reservoir, then, the possibility of an entirely new additional flow, for purposes outside of the uses heretofore made of the water from this watershed, immediately becomes available. The water from the new Lake Spaulding reservoir has its outlet through a tunnel whose length is 4600 ft. This has been bored through the solid granite of the hill which forms the south side of the gorge. By a curious freak of topography, the South Yuba River after leaving the gorge, turns north. It is probable that at one time it maintained its generally southwestern direction passing through what is now Bear Valley and the Bear River Canyon. At sometime, due to some cosmic disturbance, the river bed was cut below the point of entrance to Bear Valley and forced its way through the hills to the north. At any rate, it now follows the gorge of the South Yuba and eventually joins the Main Yuba above Smartsville. The outlet from Lake Spaulding is at the head of Bear Valley which is also at or near the source of the Bear River. From this point an open canal carries the water, following the hillside above Bear Valley, and then the Bear River canyon for a distance of nine miles until the grade of the canal and the slope of the longitudinal ridge meet. There is a peculiar characteristic of these ridges, in that, as the ridge gradually lessens in altitude, the outlines become broken, into a series of buttes. Such a condition is presented where the canal meets the top of the ridge so that it is necessary to carry it across the first gap in order to seek its level again by an inverted siphon. Beyond this siphon is the forebay for the Drum power development, the largest power plant of the series.

Going back to the dam, the difference in level between the full lake and the outlet tunnel is 230 ft. As this lake will be full for several months of each year, and as it will require the remainder of the year to draw down to the outlet tunnel level, there will be a period probably of eight or nine months when the head between the surface of the lake and the outlet tunnel will be available for power. Particularly is this valuable because this power will be available for a large part of the time when there may be a shortage of power at other points. This drop will develop power under full head to about 6500 h.p. A power plant has been introduced in the tunnel itself. This plant is located about 1000 ft. from the mouth of the tunnel and some 800 ft. below the dam measured along the river. A cavity was made above the tunnel in the solid rock. From the intake to this cavity the tunnel is necessarily under pressure and has been lined with concrete of which a small portion is reinforced. Just before reaching the power house cavity an uplift has been made in which a steel pipe is carried from the tunnel proper through the uplift into the power house cavity. This pipe will lead directly to a Francis turbine which will be direct connected to a 5500 kw. generator. There are also 2-36 in. relief valves. Both the relief valves and the turbine will discharge back into the tunnel, which is below the power house floor. The flow therefore into the tunnel must pass either through the turbine or through the relief valves. Just below the power house and entering the tunnel is an adit which primarily was used to assist in the construction of the tunnel. The adit is now used as a surge outlet and also as a waste way. From this point to the lower portal the tunnel is unlined, it being in solid rock of a very permanent character and further support or lining has not been deemed necessary.

The Drum plant is located on the south side of Bear River. There are to be two pipe lines from the forebay to the power house, but one having been so far installed. These pipes each have a capacity of 300 sec. ft., with a diameter at the top of six feet and taper through three diameters to 52 in. The total hydrostatic head is 1375 ft. and the length of the pipe line is 6200 ft. For about two-thirds of the distance the grade on the pipe line is not great and at one point there is a siphon but the remaining one-third of the distance the grade is at a maximum angle of 40 degrees with the horizontal or about 80 per cent.

The forebay has a capacity of 399 acre feet and is sufficient to operate the power plant for about nine hours in case the water supply should entirely cease. This is in addition to the storage requirement for operating the plant to full capacity over peak loads.

The Drum power house will have an ultimate capacity of 50,000 kw. This will be divided into four main generating units of 12,500 kw. each. In determining the size and number of units for this plant it was necessary to make a very careful study of the load conditions which would probably obtain at this point. The average flow of water is sufficient to maintain a load of 28,000 kw. and it has been found that the station load factor due to a combination of complex conditions should be about 68 per cent. This will vary during different periods of the year but the figure given is an average which it has been estimated by the company engineers, will give a daily load variation between 15,000 kw. and 50,000 kw. Upon this basis, therefore, the plant has been designed to operate when necessary, at the higher value. The power house has been built and finished for the complete installation with the exception of the transformers and generators. In this respect one-half of the installation has been made and is now in operation, the other half amounting to 25,000 kw. will be installed in the near future. Water as it is discharged into the Bear River from the Drum plant will be diverted into a canal, this time on the north bank of Bear River. This canal will have a length of 8.5 miles to the point of the second drop. At this point, there is a fall of 826 ft. and power house No. 2 will

The Lake Spaulding Dam Site Looking Down Stream, Showing the Preliminary Work and Foundations Completed in 1912.

Steel Frame Structure for Drum Power House.

Clearing Bedrock for Foundation of Lake Spaulding Dam.

Building Masonry Wall in Lake Spaulding-Drum Canal.

be placed at the edge of Bear River but on the north side. Here the water will be again taken up and a third canal on the same side of the river will continue a distance of 9.0 miles until a third drop is reached. Here a fall of 500 ft. will be possible with the power house situated in a similar manner to No. 2.

The power installation in No. 2 plant will be in two units of 12,500 k.v.a. each; that of No. 3 plant will be in two units of 8000 k.v.a each. From No. 3 power house the water will be allowed to discharge into Bear River and will follow this stream for a distance of two miles, before being again diverted.

The old diversion from Bear River which was made in 1852 as the commencement and a part of the Bear River and Auburn Mining and Water Company, and which was referred to at the beginning of this description, is to act as the continuation of the Lake Spaulding development.

During the years of 1912 and '13, the canal leading from this diversion and for a distance of 23 miles was enlarged from the original section which had a capacity of about 40 cu. ft. per second to a new section having a capacity of 350 cu. ft. per second. This enlargement was made in view of the additional amount of water which would be delivered into the river from the new plants to be again taken up for further use, as well as to carry the natural water of Bear River, within the limit of water rights owned by the company. In making the enlargement of this canal, about nine miles was eliminated by constructing two tunnels, whose total length is less than one mile. A section of new canal including a tunnel, was built at the end of this enlargement for a distance of one mile to a point where a reservoir has been constructed, known as the No. 4 Regulating reservoir and which has a capacity of 885 acre ft. There are two earth dams in this reservoir, as its site was originally a valley which required closing at both ends. This reservoir forms not only a small storage on the line of canal, but is also a forebay for power plant No. 4. The pressure line to this plant starts from the reservoir in a tunnel or as a matter of fact two tunnels, whose portals are separated by 250 ft. of wood stave pipe 8 ft. in diameter. From the lower portal of the second tunnel a wood stave pipe 8 ft. in diameter follows the contour of the hill for a short distance and then drops to the power house, giving a total fall from the surface of the reservoir of 342 ft. The total length of the pressure line is 5364 ft.

Power House No. 4 is located at the edge of Dry Creek, in reality, in the center of a broad field which slopes gently toward the creek. This power house is in architectural design of the general style used at the other of the newer power plants of the system. Like the Drum power house, it is a steel frame building, with reinforced concrete walls and roof. The installation here consists of one main generating unit. The generator is rated at 12,500 k.v.a and is similar in design to the machinery at Drum. On either end of the shaft is a Francis turbine water wheel of 18,000 h.p. The transformer and switch equipment of this plant is similar to that of the Drum plant with the exception that it is in size suitable for a smaller installation.

In Dry Creek below No. 4 power house is a rock filled dam with a masonry face. This forms a small reservoir into which water from the power house is discharged and it also acts as a reservoir from the canal and power system which extends beyond it. From this reservoir the canal is carried partly in open ditch and partly in two tunnels aggregating 3600 ft. in length, to a reservoir which is under construction in Rock Creek. This is purely a storage reservoir and has a capacity of 2000 acre ft.; it is to be formed by a low concrete dam whose maximum height is 40 ft. and the length 900 ft. From this reservoir the canal is continued, its outlet being somewhat above the dam taken from one side of the reservoir. The canal follows a gentle side hill for a distance of 3½ miles until it is within the city limits of Auburn. In this particular section of canal, there is a rock cut, which is of interest from the fact that it required a double cut by the steam shovels which have been employed throughout in this work.

Placed on the top of a narrow ridge is a forebay reservoir for power plant No. 5 into which the canal empties. This forebay is formed by a long concrete wall almost paralleling the ridge of the hill, and has a capacity of 40 acre ft. The pressure line for power house No. 5 probably the longest pipe line of its kind in California, if not anywhere in this country, has a length of 8555 ft.

There is one tunnel which has a length of 504 ft. and this tunnel which will be lined with concrete is 96 in. in diameter and will be under pressure of not over 20 lb. per sq. in.

Power House No. 5 is located at the edge of Auburn Ravine about 1½ miles below the city of Auburn. This power house is similar in appearance and construction to the No. 4 plant, but having a higher head, will have a water wheel capacity of 19,000 h.p. In it will be installed one 12,500 k.v.a. main generating unit. Water from this plant will be discharged into Auburn Ravine but will be immediately diverted by means of a low concrete arch dam into a canal which will follow the side hill for a distance of 4.5 miles until a point is reached where a second drop into Auburn Ravine is possible, this drop will have a fall of 500 ft. and upon the south bank of the ravine will be placed power house No. 6, the last of the seven power houses to be installed on this system. This plant will contain one generating unit of 10,000 kw. capacity. The water discharged from No. 6 will be at an altitude of 430 ft. It is possible to construct canals and to carry this water still further in southerly, northerly and westerly directions, where it will be avaliable for irrigating 75,000 acres of low foothill land. A small part of this land is now under irrigation, but all of it is suitable for the best deciduous fruit culture and its reclamation from a condition of semi-aridity forms a very valuable asset to the growing resources of this already wonderfully productive section.

The power from the various plants will be transmitted at 100,000 volts to the Cordelia switching station. The main line of this transmission will commence at the Drum power house and from this point it follows approximately a tangent to the south side of the Sacramento Valley near Winters, thence it takes a more southerly direction passing across the

Vaca and north of Pleasant valleys, eventually emerging from the hills near the switching station at Cordelia. The total length of this line is 109.5 miles. The connections for other power houses will be made by 3 branch lines. Power house No. 2 is distant about one mile from the main line and will be connected by a loop. Power house No. 3 is slightly further away but will have a similar connection. Power houses 4, 5 and 6 are some distance south of the main line. This will require a branch which will commence with power house No. 4 passing through No. 5, thence to No. 6, and then continuing in practically a tangent line to a sectionalizing and transformer station at Nicolaus. This branch line will have a length of 34 miles, and will operate at 60,000 volts potential. At Nicolaus a junction is made with four transmission feeders of the net work. These are the lines from Colgate power house; the lines from De Sabla and Centerville power houses, and the connections to Sacramento and the auxiliary steam plant at this point. At the terminus of the line at Cordelia are placed single coil tranformers which reduce a line voltage of 100,000 to the network voltage of 60,000, this is the central distribution point for the entire system and is a logical point of delivery for the new power.

It will be impossible in this paper, due to lack of time and space available, to treat the various parts of the new system in any but the most brief detail.

### Work Equipment.

In proceeding with so large a construction covering many points as is the case in this project, the works equipment necessary must be very complete and expensive. Camps to the number of 28 have been maintained, many of them from the inception of the work to its completion, while others have been temporary or removable. The commissary department has been very carefully conducted to prevent waste and excessive cost, but it has been the policy of the company throughout, to maintain its camps in the very best manner which good food, material and careful planning could give. This principle has had a noticeable result in high manual efficiency.

At Lake Spaulding the first requirement was a continuation of a spur track from the Southern Pacific to the location of the new dam. The old spur track, which had a length of one mile and ran to a sawmill was purchased by the company for its own use. The continuation of the track to the dam has a length of 1.3 miles. In some places was encountered rather difficult work of construction and there are three trestles. At the dam site, but somewhat above the crest of the dam, is the works plant, which consists of a compressor house, in which are compressors having a total capacity of 1408 cu. ft. of free air per minute compressed to a pressure of 100 lb. per sq. in. Each of these compressors are driven by a 125 h.p. 440 volt induction motor. At the end of the railroad line and on the side slope of the hill, immediately above the dam are constructed storage bins for the crushed rock and gravel. These have a capacity of 1500 cu. yd. At the extreme end of these bins are two No. 6 McCully gyratory crushers and back of these there is a quarry from which the rock is taken, which is run through the crushers. It is therefore possible to place the crushed rock in the bins or to dump gravel or sand from the cars as may be required. On the lower side of this track and close to the bins is a cement storage house and adjacent to this is a mixer house. The latter is in four stories. Gravel or rock is conveyed from under the bins on belt conveyors to the top of the mixer house and is here distributed into measuring hoppers. The cement is brought in by a belt conveyor from the storage house; and the mixing of the gravel and cement is done on the second floor of the mixer house. On the first floor of the mixer house are four 1½ yard Smith mixers. The remainder of the equipment at this point consists of a machine shop and blacksmith shop. Stretched across the canyon above the dam are two aerial tramways, each having a span of 1400 ft. The suspension cable in each case is 2 in. in diameter and is a special cable of treated plow steel, the strands being of special shape so that they lay perfectly smooth and occupy all of the space. This cable has a breaking strength of 170 tons. At the south end are the operating cabins. These contain a variable speed hoist and traversing line control operated by a 112 h.p. induction motor.

All material except concrete, has been transferred from the head works in the construction of the dam by these cableways. Concrete for the dam has been carried to the point of deposit in wooden chutes.

When the work was first started a patent "U" shaped steel chute was installed, this was found to be totally inadequate to the service required and a simple flume 30 in. wide and 12 in. high, very much like a water flume was substituted to facilitate the flow of concrete. The bottom of this flume was paved with cast iron plates 15 in. wide by 30 in. long; these were cast about ⅝ in. thick. The chutes after leaving the mixers were carried on a slope of 1 to 3 to the edge of the vertical cliff. At first a wood and later a structural steel tower was constructed below the cliff and within these, short sections of chutes constructed as baffles, were built, allowing the concrete to drop to the bottom of the tower where it was discharged into a second chute or series of chutes which distributed it in the dam.

As the crest of the dam raised, chutes were taken from one side of the towers, until a point was reached where the concrete would not flow from the mixers to the towers. In order to distribute the concrete after the dam had risen to the height of 175 ft., a belt elevator was installed on the top of the highest tower and this raised the concrete to a point where it could again be dispersed. A second elevation was later installed, so that concrete could be distributed to the further end of the dam, 50,000 yd. in all being handled in this manner.

Work upon the dam under the charge of Mr. Frank G. Baum, as chief engineer, commenced in the fall of 1912 and lasted until the winter prevented further operation. The work consisted mainly of excavating gravel, and faulty rock and filling the holes and surface irregularities with concrete. It was necessary to make elaborate provisions for handling the water as the canyon is narrow, and by the time that work had actually commenced, water had to be taken care of. This was done at first by a water flume at one side of the canyon, later the outer form of this

Upper and Lower Faces of Lake Spaulding Dam Nearing Completion.

flume was replaced by a concrete wall of sufficient strength to withstand any flood which might come through. Following this a second concrete wall was built and during the winter the river flow was carried between these walls. Across the canyon at the upper toe of the dam a solid concrete wall was built, having a total height of 35 ft; in this wall were installed two temporary openings about 6 ft. square over which were hung timber doors by which the flow of water could be controlled.

It was possible throughout the winter and spring to confine the water between the two walls, this channel was, however, intended only for temporary use and was later filled in solid with concrete.

The actual work of constructing the Lake Spaulding Dam was commenced in the latter part of May of this year. While the plant had been able to show what its capacity might be, it had not been put to any real test.

The material of which the dam has been built has been the subject of much study and some experimentation. When the construction plant was first built there was discovered at a point about midway between the dam and the old spur track to the sawmill, a large deposit of glacial sand. This promised to supply all of the material that would be necessary in the work. It was found that this sand contained a certain amount of silt so that washing became necessary. A heavy hoisting engine with a drag line scraper was installed, and also a washing plant, to which the sand was delivered by an endless belt conveyor. A second sand deposit was discovered on the line of an old lumber narrow gauge railroad, about midway between the main camp and the old Lake Spaulding. Soon after work commenced in the spring of this year, it was found that the sand supply which had been provided while sufficient in quantity, would be totally inadequate to supply the amount of sand

at the required speed necessary within the available cost.

Mr. Baum immediately began to look around for other sources of sand supplies. In this connection he discovered an available supply near Wadsworth, Nevada, this being a sand and gravel formation, clear of silt, and of a mixture in approximately the correct proportion for the concrete. Another source of supply was discovered in the Bear River near Colfax. Here the material was also in the form of gravel and sand in proportion very close to the desired mixture. Sand was also shipped from the Yuba River at Marysville. After having shipped many carloads from these sources it was determined that the Bear River sand could be handled and delivered not only cheaper, but in the desired daily quantity, which would not have been the case with the other sources. With the final adoption of the Bear River sand and gravel the quarry at the dam was virtually abandoned as it was found that the cost of getting the sand by drag-line buckets or steam shovel, loading into gondola cars, shipping to Lake Spaulding over the Nevada County Narrow Gauge and the Southern Pacific Railroads, and delivering directly into the bunkers at the dam, was cheaper than quarrying the rock, crushing it, and mixing with sand from other sources. The Lake Spaulding dam is therefore largely constructed of the quartz gravel and sand from the Bear River with but a small proportion of the Wadsworth gravel and of the native rock. In determining the condition of the concrete, a test house was erected close to the mixer house, and in this was placed a Riehle testing machine having a capacity of 50 tons, and other apparatus for testing boiling pats, and making tensile tests. Throughout the work samples of green concrete were taken from the dam after the concrete had been deposited, these samples being obtained at various points in the dam. Enough samples were taken every day to supply 3 for a 7 day test, 1 for a 28 day test, 1 for a 60 day, 1 for a 90 day, and 1 for a 5 year test. These samples were kept carefully indexed on shelves provided in the test house, and maintained in a moist condition by wet gunny sacks thrown over them. Each day the test samples, as their time became due, were broken, and very complete records were made on each to determine the condition of the mix, and to make any corrections necessary.

The proportion of the mix which has been generally used, and which was found satisfactory, was 1 part of cement, 2½ of sand, and 4½ of gravel. This is practically the proportion in which the sand and gravel is received. After very careful consideration it was found that while this was not the ideal mixture for greatest strength it was less costly and equally satisfactory to use a slightly greater amount of cement rather than sift the sand from the gravel and remix in absolutely correct proportions. The average time of mix given was 2 minutes. The average breaking strength per sq. in. was about as follows: 7 day specimens, 400 lb.; 28 day, 900 lb.; 60 day, 1000 lb. Ultimate strengths will of course exceed these amounts very much.

When the Spaulding dam was first proposed various consulting engineers made reports on the type of dam which would be necessary at this site. The site is so ideal for a high dam, and is, practically speaking, so narrow that the design of a curved dam immediately suggested itself, depending upon the curve altogether for the strength of the dam. Several of the early reports made on this dam were for a gravity type, including a curve upstream. These reports on this type of dam were made probably more as a matter of precedent than from expediency. The company, upon the commencement of work, had practically decided to adopt a dam of gravity section. After Mr. F. G. Baum came in charge of the work, in the fall of 1912, he proposed that the section be cut down, both as a matter of cost and from the fact that a curved section built upon the principle of the varying radius would offer all the safety factor which might be expected from a full gravity type dam. It was finally decided to begin the dam, using a gravity section for a height of 260 ft., which height it was proposed to build to during the year 1913. It was further proposed to continue this height to 305 ft., which would be the full height of the dam, and the continuation would be designed on the principle of the arch to resist the water pressure. Work was commenced on this plan in May, 1913, and the thickness of the dam was made 186 ft. at the bottom of the river. The upper face was made nearly vertical, while the lower face was stepped, the steps being 3 ft. high and 2 ft. wide, the radius adopted for the dam commencing at the bottom and extending up for 75 ft. was 250 ft. When the dam had reached a height above the foundation of 60 ft. it was decided on account of financial conditions not to attempt to carry the dam higher than 225 ft. during the present year. It was further decided that it would be possible to drop back the lower face so that the section as carried up from this point would be a pure arch. This section to be left so that the full height could be carried out by filling in the lower face and bringing the dam to 305 ft. In designing the ultimate dam, the stresses in compression adopted were all kept within 24 tons to the square foot, equivalent to 333 lb. per sq. in. as a maximum limit, gravity action not considered. In the lower 60 ft. the stress amounts to but 14 tons. This increases slightly until a height of 260 ft. is reached, when the stress becomes 23.9 tons, and this immediately falls off to zero at the top. The final designs were approved by Arthur P. Davis, Chief Engineer of the United States Reclamation Service. To prevent the collection of leakage water under pressure at any point in the dam there is a very complete system of vertical vent pipes. These are 8 in. wrought iron pipes, which run from the bottom to the top of the dam, the joints of which are not tight. There are four vertical transverse expansion joints from elevation, 75 ft. to the top. An inspection tunnel runs down on a slant from either end of the dam, and is joined by a horizontal tunnel near the bottom. Into this any leakage water will be carried. The waste outlet for the dam is just below this inspection tunnel, and contains a hand-operated 30 in. gate valve. The present height of the dam is 225 ft. The length of the crest is 580 ft., the amount of concrete which has been placed is 155,000 cu. yds., the variation of the radius from the elevation of 70 ft. above the foundation to the present crest is from

250 ft. to 400 ft. The upper face of the dam above the 75 ft. elevation has a batter of 1 in 6.

### Outlet Tunnel.

The outlet tunnel has its intake at a point about 50 ft. back from the upstream face of the dam. This intake is covered with a heavy grating of flat steel bars set on edge, and is the end of a steel thimble or pipe which extends into the tunnel to a gate chamber. This intake pipe tapers from 10 ft. to 6 ft. at the gate. The gate has a cast steel butterfly valve, which is operated through a lever and gear mechanism by either a hand wheel or 7½ h.p. induction motor specially designed for the purpose. Access to this chamber is had through a tunnel which connects with the inspection tunnel into the dam, this tunnel being driven through the rock, and by means of a vertical shaft is brought above the dam to a gate house. There is an upper adit to the outlet tunnel. It is placed 100 ft. in elevation above the main intake, and is connected to the main tunnel by an incline shaft. The intake tunnel is lined with concrete for a distance of 1000 ft., the upper adit and shaft being likewise lined. This lining terminates in an upraise pipe into what is known as the Spaulding power house, which has been already briefly described. The remainder of this tunnel is not lined, and acts as a flow tunnel, as the water is not under pressure.

### The Drum Canal.

The problem of design of this canal offered a number of rather complex situations. The country through which this canal passes is all side hill, some of it very rough, partly solid rock, partly broken, some of it is in earth which is more or less treacherous, and at all points it is subject to snowslides and other interferences which might be expected where a more or less severe winter climate exists. It was at first proposed to excavate a canal and to line it with reinforced concrete and with a reinforced concrete cover. After a careful study of the problem, in which the extra cost of concrete lining had to be considered, and also the time necessary for construction, it was decided for the present to build this canal as an open ditch, but at all points where there was danger of breakage or slides, or where the current of the flow might cause a wearing away of the canal berm, a rubble rock wall of very substantial proportions was constructed on the outer berm, while the inner berm was lined with a dry rock wall. As practically every place where it was necessary to build this masonry construction was a cut in rock or hard formation, the bottom of the canal is practically as solid as if it had been lined with concrete. The entire work of excavation of this canal was done by means of steam shovels—three 1½ yd. and one 2½ yd. shovels were used. The operation records of these shovels show that the larger shovel, which had a longer boom, was very much more efficient than the others. The average daily record of this shovel through the worst rock conditions was about 300 ft., while there were days when the shovel made over 500 ft.

Just before entering the fore-bay of the Drum plant it was necessary to construct a siphon in order to cross a saddle in the ridge which supports the canal. This siphon is 8½ ft. in diameter, and is constructed of 5/16 in. riveted sheet steel. The length is 1888 ft., and the greatest static head of the siphon is 128 ft.

### The Forebay Reservoir.

This reservoir, which is perched on the top of a knoll, is partially an excavation and partially a fill. The economic size of the reservoir was determined from a study of operating and plant conditions which applied on this system. It has a capacity of 399 acre ft., and is about one-half of the maximum size which could have been constructed at this point. It, however, represents about the lowest cost per acre ft. which would be possible here. In construction the work consisted entirely of plowing the ground, surfacing out the higher side of the hill, and transporting the loosened earth by Fresno scrapers which dumped through traps into wagons, and was distributed on the dam around the lower side of the reservoir, or was transported directly by wheel scrapers on to the dam. The greatest care was exercised in constructing the dam. The earth, of which the dam is made, is a gravelly clay of a red color, which overlies a hard cemented gravel. There was, to begin with, a layer of light yellow volcanic ash over the entire site which was not considered suitable as a material to put in the dam. This was all scraped off and discarded, amounting to about 75,000 cu. yd. The foundation of the dam was ploughed 2 ft. deep and tamped back. As the material was deposited it was wet thoroughly, harrowed, tamped with a petrolithic roller, and then with smooth rollers, forming a very compact mass. The greatest height of the dam is 54 ft. The inside slope is 3 to 1, the outer is 2 to 1 near the base and 1½ to 1 above; the width of the crest is 12 ft. From the inside edge of the crest down the slope for a distance of 50 ft. there is a paving of hand-placed rock. Below the line of this paving and across the entire bottom of the dam the earth was ploughed, puddled and tamped to make a water-tight and impervious lining. The canal enters at one end of this reservoir, and passes directly through to the point of intake of the pipe lines. There is a drop from the end of the canal, which follows the slope of the reservoir to the bottom, which is paved with rock. The continuation of the canal along the bottom of the reservoir is about 3 ft. deep and 35 ft. wide. The intake to the pipe lines is at the foot of the inner slope on the north side of the reservoir. It consists of a concrete enclosure, which is open on one side to the ingoing canal. The two openings into the pipe lines are formed of reinforced concrete, and have steel gratings to prevent the entrance of any detritus. These openings are 8 ft. in diameter, and taper to 6 ft., the diameter of the pipe which is brought into this taper so that the concrete surrounds the pipe, making a tight joint. The tunnel was built from the intake to the side hill, which forms the outer slope of the north side of the reservoir. This is a two compartment tunnel, part concrete and partly timber lined, and having a length of 328 ft. The pipe lines are laid side by side through this tunnel. On a level space, beyond the portal, is placed in each pipe line a 6 ft. butterfly valve, which is similar to the intake valve of the tunnel from Lake Spaulding.

### Pipe Lines.

For the present installation but one pipe line is in place. This has a length of 6194 ft. The diameter at the top is 72 in., and the thickness is ¼ in. This thickness increases with the head on the pipe

Siphon in the Spaulding-Drum Canal. This Was Necessary to Avoid Crossing a Corner of the Tahoe Forest Reserve. The National Forest Is Shown on the Left Side of the Pipe.

until at the power house the thickness is 1¼ in. The diameter for 4100 ft. remains at 72 in. It then is reduced to 66 in., then to 60 in., and finally enters the power house at 54 in. The material of the pipe is low carbon open hearth steel, and it is lap riveted to a point where the head is 262 ft., the straight seams being double riveted, and the round seams having a single line of rivets. Beyond this point the pipe is all butt and strap joint. In the heavier sections the straps are butt and strap-jointed, as in working with very heavy material it is impossible to lap over corners. Throughout the length of the pipe line it is laid in a trench, but in most cases is only half buried. There are some few instances where the pipe is entirely on the ground surface. The last third of the pipe has an average slope of about 40 degrees with the horizontal. There are in this section three anchorages. At a distance of 260 ft. back of the power house, in order that the pipe may enter the building horizontally, it is passed down through a concrete lined tunnel for a length of 256 ft. The pipe enters this tunnel on a slope of 32 degrees, and makes a turn to the horizontal before leaving the tunnel. The upper part of this tunnel, and also to a point below the turn, is back filled with concrete, and this forms the first anchorage. The only effective thrust on a pipe, except for the end thrust, will occur at sharp turns. In the steep section there are two turns, which include both horizontal and vertical angles. Near these turns are placed two anchors. These anchors are unique in design, and consist of a reinforced concrete ring 4 ft. wide, with a thickness of about 30 in., which is bonded to the pipe by three bands of angle steel 6x4 in., riveted to the pipe. These concrete rings, whose weight is supported on a foundation of their own, are held in place by sixteen 2 in. bolts with turnbuckles. These are equally divided into two groups on each side of the pipe, extend backwards along the line of pipe for 24½ ft., and are imbedded in a heavy block of reinforced concrete as an anchorage, this anchorage being placed on a horizontal shelf under the pipe, and cut well back into the hill. At a point about 4000 ft. along the pipe, which point is at the foot of an incline from the summit of the inverted siphon, is placed the fourth anchorage. This consists merely of a block of concrete under the pipe, to which the latter is anchored from both directions by ¾ in. x 10 in. steel straps riveted to the side of the pipe.

Transporting an Allis-Chalmers 1250 k.v.a. Transformer Down the Tramway to the Drum Power House.

Looking Down the Pipe Line Toward the Drum Power House. A Pipe Anchor Is Shown in the Foreground Before the Pipe Had Been Laid.

There are three expansion joints in the pipe. These are slip joints of a conventional type, which are packed with hemp. In a pipe of this length, even when filled with water, a variation in temperature may occur between the freezing point, or little above, say 35 deg., F., to probably 70 deg., F. The under half of the pipe being next the ground, is protected, but the total variation is due to the difference in temperature of the water between winter and summer. A rise in temperature of 35 degs. will make possible a total expansion of 13.8 in. in this pipe line. Much of this expansion may be taken up by distortion, which in reality would be very small, but in the heavier pipe might court disaster, consequently, to make doubly sure, the expansion joints have been provided.

Relief valves are placed at three points on the pipe, the first set being at the outlet of the forebay tunnel, the next at the top of the inverted siphon, and the third set at the summit of the steep incline. The time of closing with a reservoir empty, which will still leave 25 ft. head on the inverted siphon, is designed for 30 seconds on the power house main gates, but the butterfly valve at the top of the pipe requires two minutes to close.

For the convenience of construction a railroad three miles long was built from the Southern Pacific at Orel, including three switch backs, to a point at the beginning of the inverted siphon which is in a saddle of the general ridge. Here also was located the warehouses and works camp. For the purpose of transportation of machinery and supplies to the power house a standard gauge track was built from the works camp parallel with the pipe line to the power house. This section is operated by cable and hoist, there being a 150 horsepower hoist located at the top of the inverted siphon which has a double drum with a cable working in both directions. A second hoist was placed at the head of the steep section of the pipe line, and the track down this section is known as the incline. A 1⅛ in. cable is used here to insure safe operation with heavy loads, which in some cases were over 40 tons. This incline is the spectacular feature at this point of the system.

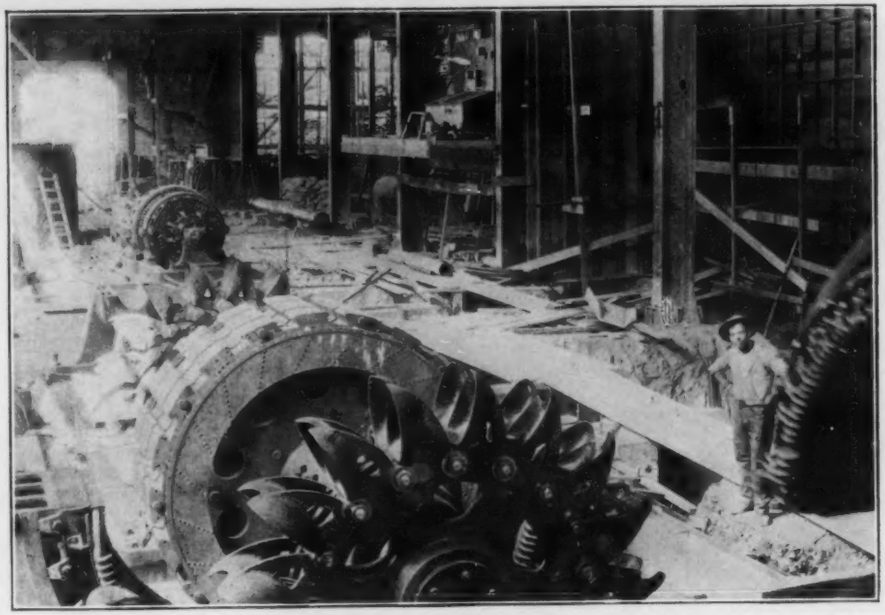
The Drum Pipe Line and Tramway Incline as Seen From the Roof of the Drum Power House.

### Power House.

The power house is a steel frame structure designed to stand without the aid of supporting walls for a horizontal wind strain of 25 lb. per sq ft., and with a roof to carry a snow load of 30 lb. The building is rectangular, 209 ft. long and 78 ft. wide. The roof has an uneven hip with slight slope, and is 65 ft. above the floor. The floor line represents the bottom of the excavation which was made for the power house, the only cuts in this floor being those for the generator bodies and the tail races of the water wheels, and for the incoming pipe lines. The building in its design and general layout is typically representative of the best western high head practice. The main generators, of which there are to be four, are placed with their shafts on a center line lengthwise of the building and toward the front walls. The exciters are placed on two lines, which, however, rest between the two center generators, the exciters being right and left handed. Through the center of the building is a line of supporting columns, and between the front wall and this line of columns is formed the main bay or generator room. Between the generators and the center line of columns is a space sufficient for moving about and transporting machinery or parts from one end of the building to the other. The generators, furnished by the Westinghouse Electric and Manufacturing Company, are of the standard water wheel type, the armatures being mounted on cast iron bedplates, which are in turn mounted on the concrete foundation. The bearing standards are likewise supported. These have non-aligning bearings, self-oiling and water-cooled. The shaft is of nickel steel, is hollow, and extends beyond both bearings to carry the water wheel runners. The generator armature is 3-phase and star-connected for 6600 volts. The rotor is made up of three nickel steel discs placed side by side, about the periphery of which, are dovetailed the field coils. The armature and rotor are covered on either side by cast iron end-bells, which have outlets similar to those of a centrifugal blower. The movement of the rotor and the design of the field bobbin ends causes a strong flow of air, which is drawn from the tail races, and is forced through the armature windings and field laminations. These machines operate at 360 r.p.m. and have a rating of 12,500 k.v.a. The water wheels are housed in a cast iron casing, and are equipped with needle deflecting nozzles, which are operated by specially designed Lombard type governors. These have horizontal operating cylinders which exert a pull equivalent to 20,000 ft. lb.

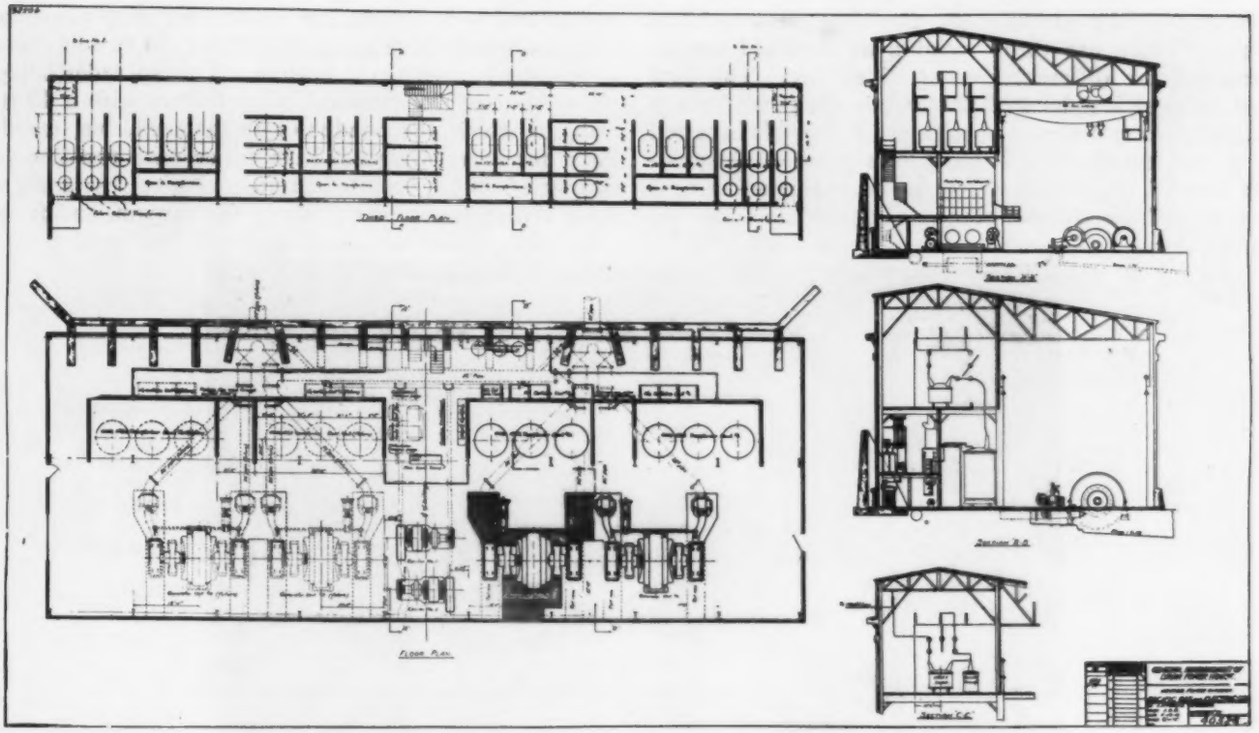
A Typical Flume on the Spaulding-Drum Canal Line.

The Drum Power House.



Interior View During Construction of the Drum Power House, Showing Partially Erected 12,500 k.v.a. Generating Set, Exciter Unit and Switchboard.

A Finished Section of Spaulding-Drum Canal, Showing Rubble Masonry Wall on One Side and Dry Rock Wall on the Other.



Transverse Sections and Floor Plans of the Drum Power House.

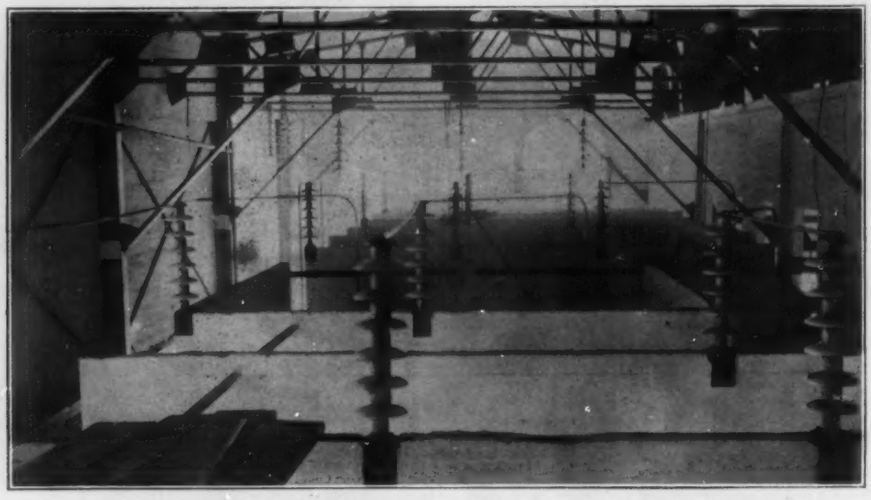
The main pipe line enters the rear of the building, and branches through a cast steel Y. To each leg of the Y casting there is bolted a 36 in. water wheel operated reversing gate valve. Bolted to each valve are secondary Y's and from each of these a sheet steel riveted pipe 26 in. in diameter is carried to each of the needle nozzles, all, excepting the valve bodies, being below the floor level. Bolted to an outlet in a cast steel section in the main pipe is a third 36 in. gate valve to serve as a connection for a third unit. The hydraulic machinery was supplied by the Pelton Water Wheel Company and is built upon the Doble patents. The switchboard occupies a space at the center of the building immediately in the rear of the center line of columns. Its floor is on a level of 10 ft. above the main floor. The switchboard consists of an operating remote control bench board facing the main operating room, and in the rear of this at right angles is the secondary board for the exciters and all auxiliaries. On either side of the switchboard place in six compartments are the transformers. There are in eacn compartment two oil-immersed, water-cooled transformers. These raise the generator voltage from 6600 to 72,000, which is eventually star-connected to give 125,000 volts for transmission. There are taps in the high-tension winding for 120,000, 115,000 and 110,000 volts. The transforming equipment was supplied by the Allis-Chalmers Company. In the rear of the transformers on a gallery at the same level with the switchboard are placed the 6600 volt generator, transformer and bus switches, and switch cells. These switches are all of the remote-control, solenoid-operated, oil-immersed type.

The high tension gallery occupies a floor over the transformers and low tension switches. The barrier system of separation into cells has been strictly adhered to in the design of this part of the power house. All high tension lines, switches and bus lines are protected by 6 in. thick concrete walls. The high tension switches installed in this plant are of a design which has been developed in the service of the company, and are in general use on the company's lines. These circuit breakers consist of cast iron tubs 4 ft. in diameter, supported on a light structural steel frame, mounted on insulators. The switch mechanism has two horizontal arms with a break at each end, making four breaks in all. These breaks are made horizontally, and the arms are supported at the lower end of a vertical operating shaft. Two of the switch jaws are mounted at the lower end of the cover insulators. The other two are connected across inside in such a manner that the four breaks are made in series. The insulators and switch mechanism is all supported from the cover of the tank, which is made of cast aluminum. The switch tanks are filled with mineral seal oil. The high tension lines leave the building through large openings in which are placed two panes of plate glass; the inner of these has a hole 12 in. in diameter, and the outer 18 in. in diameter, through which the conductor is passed. The outgoing lines leave the rear of the power house, being carried to towers, and from these are spanned over the power house, and across the canyon to the first tower of the transmission line.

### Transmission Line.

The transmission line has a length of 109.5 miles from the Drum power house to the Cordelia substation. It is throughout supported on steel towers. There are two general types of towers used on this line. The standard tower has a height of 82 ft. to the topmost point, and carries three arms, which support the transmission conductors from each end of

the arms. The circuits are therefore in a vertical plane. There are three weights of standard towers designed for different classes of service. The first and lightest weighs 4600 lb., and is designed for use on tangents and angles of not over 5 deg. It is tested to a horizontal strain at the center point of the middle arm of 18,000 lb., which is the condition in case any two of the transmission conductors should break.



High Tension Line Connections and Outlets in Drum Power House.

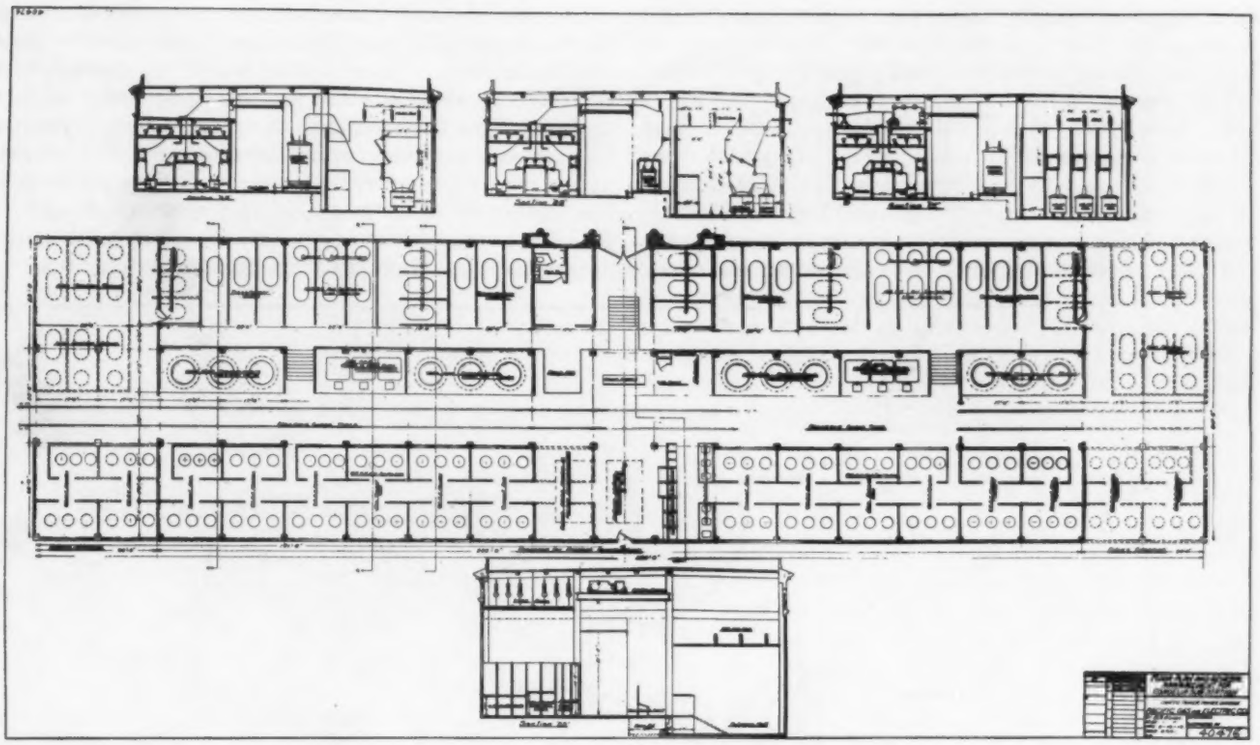
The second class, or "B" towers are designed to stand a strain of two broken wires, and spans up to 1500 ft. They weigh 5300 lb. The third, or type "C" tower, is designed to stand a dead-end strain, the longest spans and also for angles of any degree. The weight of these towers is 7200 lb. There are about a dozen cases where additions and changes have been made to standard towers for the purpose of getting extra high towers for crossing railroads, rivers and other transmission lines. The second type of tower employed is known as the "snow tower." These carry a single circuit, and consist of a pair of A frames, across the top of which are horizontal channel beams. These beams extend outside of the A frames, and support the two outside wires of the transmission. The third wire is hung from the center of the structure. These towers are designed to carry a dead-end strain, and any angle or snow strain which may be brought to bear upon them. It is proposed, in order to carry two circuits, to install two lines of snow towers, and the foundations of the second line are now in place. The weight of these towers is 4050 lb.

Throughout the transmission the footings of all towers are imbedded in concrete. These concrete bases were all set before the towers were erected, a simple pipe template being used to get the proper position. There is about one yard of concrete to each footing, making an average of 4 yd. for the tower. For extra high towers special concrete bases have been provided.

The standard towers are designed to carry two circuits of No. 4/0 copper conductor. The spacing of the towers averages about 512 ft. in the mountain section where the snow towers are used, and 800 ft. in the valley section on tangents. There are 731 towers altogether. In the mountain section there are several very interesting spans over deep canyons. The longest of these spans is 4220 ft. In two of these a spreader is used at the bottom. This spreader being merely one of the standard snow towers with a 40 ft. arm, to which the conductor is fastened, but which does not carry weight. In another case the line is supported and prevented from swinging by a steel cable strung transversely across the canyon, and from which are suspended insulators which hold the transmission wires. In the actual construction of this line but one circuit has been installed. It was found that

"Snow" Tower on Drum-Cordelia Transmission.

with the present installation of two machines at the Drum power house, and with the present condition of the power market, it would not be necessary to have more than one circuit of 3/0 copper or its equiva-



Plan and Transverse Sections of the Cordelia Substation.

lent. By using a conductor of this size, which could later be used elsewhere on the system, it was possible to make a considerable saving in this case, and this was therefore done. About one-half of the conductor is 5/0 aluminum, which is the equivalent of 3/0 copper. The long spans are 40 per cent conductivity, copper-clad wire. There is neither a ground wire or a telephone line on these towers, as the practice of this company is against these adjuncts. The insulators on this line are all the suspension type, furnished by the Ohio Brass Company, there being six sections to each insulator. At road and railroad crossings and at dead ends two strings of insulators are used at each point of support. In the first case this is in compliance with the California law, which is vague in its construction and unreasonably severe.

### Cordelia Substation.

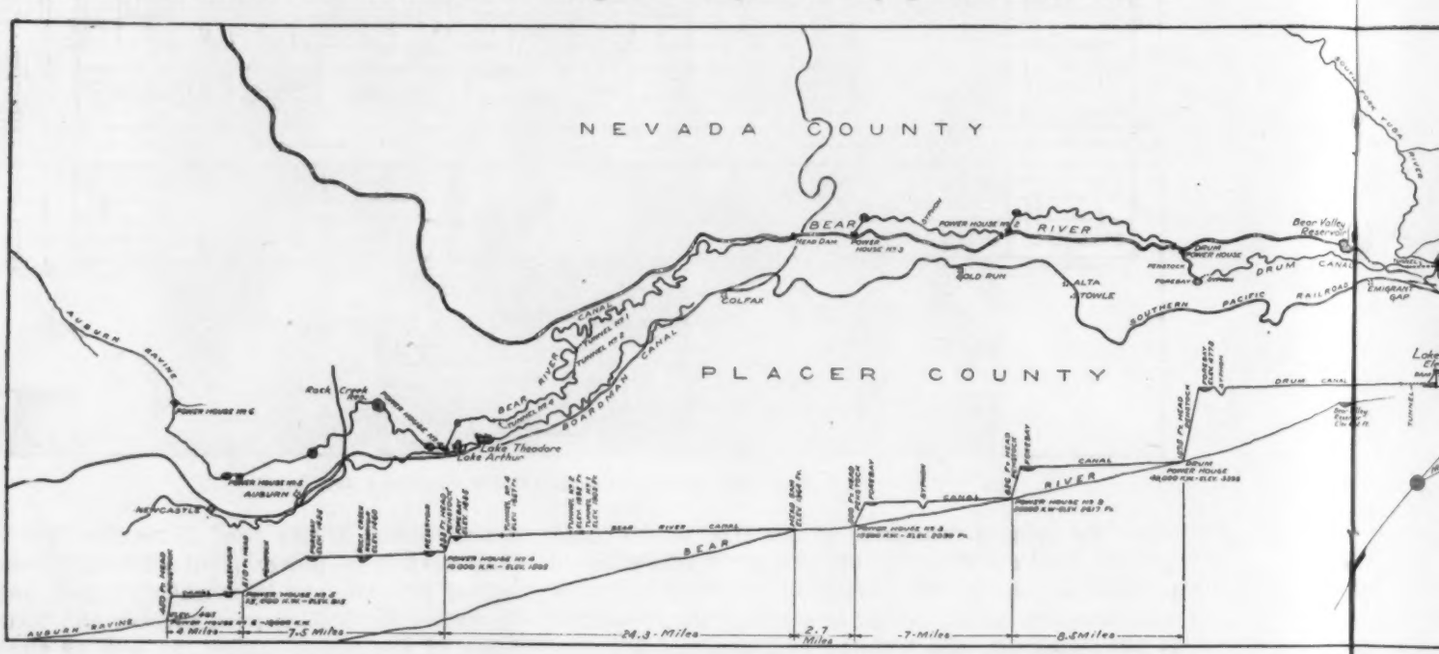
The substation at Cordelia represents practically the center of distribution of the network. After a very careful study of the situation with the possibilities of future enlargement and expansion, it was decided to make this the point of 60,000 volt distribution, practically in all directions. It therefore becomes a logical point for the end of the 100,000 volt supply of the new system. The actual center of distribution of the system is now within the Straits of Carquinez; that is, there are times when the direction of power flow is one way, and other times when it reverses. The natural trend of growth in the supply of power will be in some direction toward the source of supply. As there are several points of supply widely separated, this locus will for the present assume a segment of a circle. As the demand for power increases and the proportion of power from this system becomes greater in reference to the other power plants, this locus will shorten to a point. The determination of this point is necessarily a very complex subject in power plant economics, and has required an intimate knowledge of past and present operating conditions, past, present and future probability of the power market, as well as effects of political and municipal control. This has only been available to those who have been in closest touch with this system.

This substation is a reinforced concrete building 256 ft. long, 82 ft. wide, 43 ft. high. Architecturally it follows the Spanish Mission style of powerhouses, and is very beautifully finished. This building contains the transformers, of which there are two sets of three, 4000 k.v.a in each, for reducing the voltage of the Drum transmission of 100,000 to 60,000. These transformers are in reality balancing coils, there being but one winding in which the 60,000 volt connection is made by a 6/10 tap. In other respects the coils are similar in appearance and in operation to the transformers at the power station, except in size and weight, in which they are much smaller. The front half of the substation is devoted to the switch cells, switches and bus lines of the 100,000 volt circuits. The rear half, separated by longitudinal passageways, is devoted for a similar purpose to the 60,000 volt circuits. The switchboard is mounted at the center of the building, and controls all circuits, incoming and outgoing. This substation, like the high tension section of the powerhouse, follows the plan of complete barrier protection for all high tension lines, and is thus an intricate network of concrete walls to form the cell barriers.

### Economics of Design.

Every part of this development is dependent on every other part in forming a properly balanced whole. The power conditions for service of the Drum

plant depends largely upon the service possibilities of the other plants in the system. The capacity of the Drum plant, whose full load capacity is considerably in excess of the maximum average of the water flow, determined the position of the forebay, and hence of the pipe line. There were two points from which to choose a forebay reservoir, and three courses for a pipe line. The determination of the forebay reservoir, its economic capacity, hence its duty, made possible a close determination of the economic route




Map and Profile of the Complete Lake Spaulding Power Development.

of the pressure pipe. These points have been very carefully balanced in this plant, rather more so than is, unfortunately, the case in many modern installations. The location of the level of the forebay reservoir fixed the location of the canal and the grade, and hence the section of the canal would fix to a certain degree the point of outlet from the dam. This point of outlet in turn determined to a certain extent the height of the dam, and hence the storage possibility. The available storage possibility is, of course, determined by the duty of the watershed, but the storage availability which might have been economically advisable might be quite different from the result possible from the watershed. These values must be studied with reference to their effect upon the powerhouse design, and its effect in turn upon the remainder of the system installed, giving consideration to the cost and value of steam generated power during periods of low water in other parts of the system. It is not possible in this paper to go into the economics of the design of this plant to any greater extent than is given here, but it is hoped that enough has been given to at least start a discussion and bring out the points of greatest interest and value to the members of the institute.

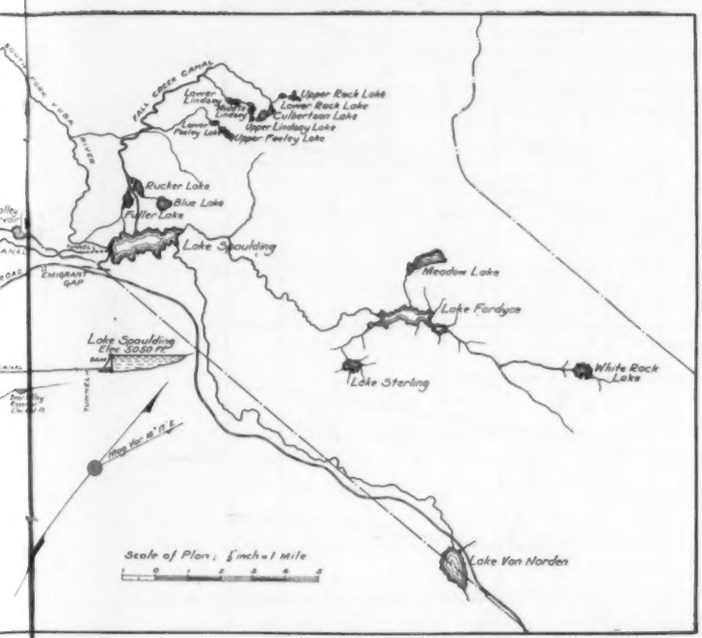
The first two units (25,000 kw.) of the Drum plant were put in operation on November 26, 1913. It is interesting to note that not only have the estimates of time and cost been realized, but that the entire system has been put into operation without a single electrical or mechanical weakness developing. This means not only careful designing and construc-

The High Tension Distribution Point and Substation at Cordelia.

tion, but is also very complimentary to all manufacturers who furnished apparatus and materials for the development.

The officers of the company are F. G. Drum, president; J. A. Britton, vice-president and general manager; A. F. Hockenbeamer, vice-president and comptroller.

The work was designed and constructed under the direction of F. G. Baum, chief engineer and general superintendent, with P. M. Downing as assistant;




H. C. Vensano, civil engineer; J. P. Jollyman, electrical engineer. D. H. Duncanson and W. H. Harrelson had charge of the dam and tunnel construction, O. W. Peterson was assistant superintendent of the canal, forebay and pipe construction, and E. H. Steele was superintendent of transmission line.

---

**Gasoline produced from natural gas** in the United States last year totaled 12,081,179 gallons (derived from 4,687,796,329 cu. ft. of gas), an increase of 4,655,340 gallons over 1911.

---

**Road making is as old as civilization,** but the application of electric power for this purpose is comparatively new. The Managers' Bulletin issued by the Pacific Power & Light Company gives a description of road-making activities in Umatilla county. A macadam road from Pendleton to the Washington line, forty-five miles in extent, is being built. One cut alone necessitated the removal of 20,000 cu. ft. of rock and this is crushed and screened by electric power and used in building the road. There are two crushers each turning out 75 yds. of rock per day, which builds 200 ft. of road at $1.50 per day for power. A portable substation transforming the 23,000 volt current to 2300 for the motor was installed in order to reduce the cost of hauling the crushed rock. The installation is described by F. W. Vincent.

## HORSE POWER TRANSMITTED BY BELTS.

BY R. GUILLON.

(Under the caption "Practical Mechanics" was published in this journal for March 19, 1910, a diagram worked out by Prof. J. J. Flather, for finding the horsepower transmitted by belting. Since that time Prof. J. N. Le Conte has discovered an error in Flather's assumptions which materially alters the final formula. A new diagram is therefore published herewith based upon the corrected formula and is abstracted from an article published in The California Journal of Technology, University of California, November, 1913.—The Editors.)

The maximum belt tensions recommended by different authorities vary considerably and are usually given without any definite statements as to thickness of belt and method of fastening. However, of the half-dozen values quoted in Kent's Pocket Book all, when reduced to parallel conditions, lie within ten per cent of those used in the construction of this diagram.

The figures used for weight of the belt correspond to a density of from 55 to 70 pounds per cu. ft. Kent gives 56 as an average figures, but quotes a rule by Webber which would require a density of 75 lb. per cu. ft. The coefficient of friction varies greatly, but is taken usually as between 0.3 and 0.4, and seldom less than 0.25. These curves may be considered as allowing a safe margin in this respect.

In this diagram (Fig. 1) Curves A show horsepower transmitted per inch of width with large pulleys and 180 degrees angle of contact for given velocities of belt and types of belting shown.

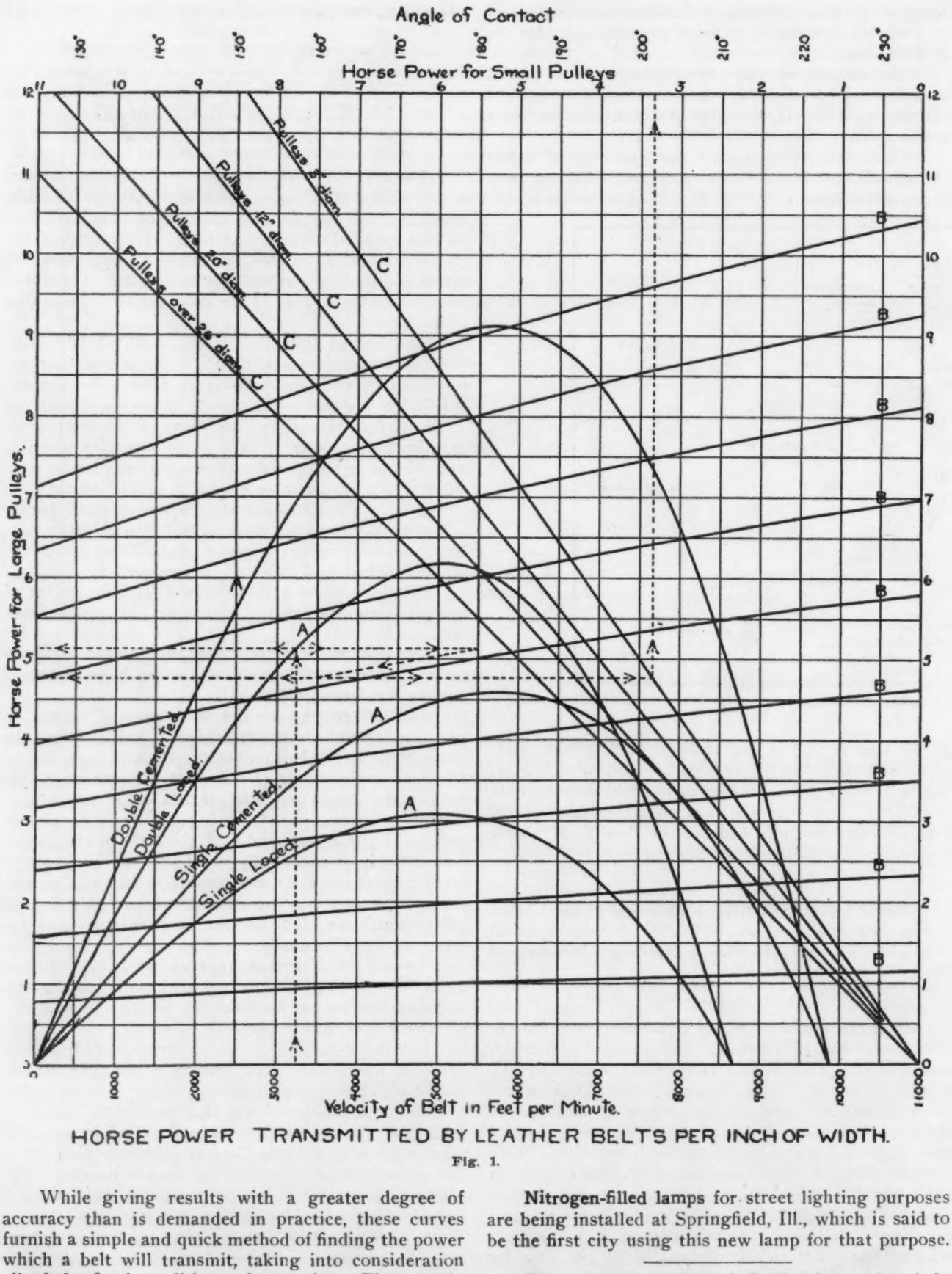
Curves B show horsepowers at varying angles of contact for given horsepowers with 180 degrees contact.

Curves C show horsepowers transmitted by small pulleys under conditions corresponding to given horsepowers for large pulleys.

The curves (A) for the four types of belting at varying degrees are plotted using 180 degrees as the angle of contact of belt on pulley. Each of the horizontal logarithmic curves (B) is plotted for varying values of the angle of contact, all other factors remaining constant. In drawing the lines for small pulleys (C) it is assumed that the ratio of the power transmitted by small pulleys to that transmitted by large pulleys for the same conditions of velocity and angle of contact is a constant depending only on the pulley diameters. The position of these lines was determined experimentally.

To use the diagrams, suppose we have a double laced belt running 3,250 ft. per min. with 160 degrees angle of contact on a three-inch pulley; to find the allowable horsepower per inch of width.

Following up the 3,250 ft. per min. ordinate to curve A for double laced belts, we find 5.13 as the power which would be transmitted per inch of width if the angle of contact were 180 degrees and the pulley large. To reduce this value to the given conditions, start from 5.13 on the 180 degrees ordinate and follow parallel to curves B to the 160 degrees ordinate. This gives 4.77 as the power transmitted with 160 degrees contact, but with a large pulley as before. To find the reduction due to the use of the small pulley, start from 4.77 on the scale for large pulleys, follow horizontally to line C for three-inch pulleys, and then up to the scale for small pulleys, reading 3.35 as the horsepower per inch of width under the conditions as given.


Angle of Contact
130° 140° 150° 160° 170° 180° 190° 200° 210° 220° 230°
Horse Power for Small Pulleys
12 11 10 9 8 7 6 5 4 3 2 1 0
Pulleys 8" diam.
Pulleys 12" diam.
Pulleys 20" diam.
Pulleys over 26" diam.
C
B
A
Double Cemented
Double Laced
Single Cemented
Single Laced
Horse Power for Large Pulleys.
0 1 2 3 4 5 6 7 8 9 10 11 12
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
Velocity of Belt in Feet per Minute.

HORSE POWER TRANSMITTED BY LEATHER BELTS PER INCH OF WIDTH.

Fig. 1.

While giving results with a greater degree of accuracy than is demanded in practice, these curves furnish a simple and quick method of finding the power which a belt will transmit, taking into consideration all of the fixed conditions of operation. They are in this respect superior to most belt formulae and tables, which as a rule neglect factors which under some conditions are apt to prove important.

**Nitrogen-filled lamps** for street lighting purposes are being installed at Springfield, Ill., which is said to be the first city using this new lamp for that purpose.

---

**The mineral wealth** of California produced in 1912, according to Edw. W. Parker of the U. S. Geological Survey was $92,837,374, an increase of $2,216,730 over 1911.

## PUBLIC UTILITY ACCOUNTING IN OREGON.

This series of articles deals with uniform classification of accounts for Electric Utilities, Gas Utilities and Water Utilities, prepared under the provisions of the State of Oregon Public Utility Act (Chapter 279 of the Laws of 1911) and prescribed by the Railroad Commission of that state.

All accounts kept by any utility within the scope of the act must be kept by the double entry method. This requirement however, is not intended to apply to purely statistical accounts.

The first entry relating to anything for which a charge or credit is made to any fixed capital or investment account must describe the property in respect of which entry is made with such fullness and particularity as to enable its identification.

For the purpose of this system of accounts Utilities are divided into three classes as follows:

Class A. Utilities having gross annual operating revenues exceeding $100.000;

Class B. Utilities having gross annual operating revenues exceeding $25,000, but not more than $100,000;

Class C. Utilities having gross annual operating revenues of $25,000 or less.

Any utility desiring a more detailed classification than that prescribed may go into as much subdivision and refinement of each of the accounts as its interests requires, provided that such subdivision does not impair the integrity of the accounts as required by the act.

### Instructions Pertaining to Uniform System of Accounts for Electric, Gas, and Water Utilities.

1. **Balance Sheet Accounts Defined.**—By "balance sheet accounts" are meant those titles (listed under the headings, "Asset Accounts," and "Liability Accounts") under which the ledger accounts are combined and summarized to show the assets, liabilities, and deficit or surplus of the business at a given time. Where the title and definition of a balance sheet account clearly indicates that it is a summary of other accounts it is not required that a special ledger account shall be raised under such a title to include the balance from the accounts usually carried on the ledger.

2. **Cost or Book Value of Securities Owned.**—The term "Cost or Book Value" as applied to various accounts representing securities owned, is intended to recognize the option of the utility of carrying its investments in securities either at cost or at a reasonable valuation other than cost. Whenever securities are acquired, they are to be entered on the book at cost. If, subsequently, the utility desires to adjust their valuation on account of substantial appreciation or depreciation, the entries in its books with respect to such securities, as well as its annual reports to the commission should clearly show the reason for making the adjustment.

3. **Re-Acquired Securities.**—The Liability Accounts for capital stock and funded debt in the balance sheet are intended to include only the par value of such capital stock or funded debt securities as have been actually issued to bona fide holders for value or such securities as have been issued by other companies and have been assumed by the accounting utility and are outstanding at the date of the Balance Sheet statement.

When Capital Stock or Funded Debt Securities have been actually issued to bona fide holders for value (or after such issue by another company have been assumed by the Accounting Utility) and after such issues (or assumption) have been re-acquired by the utility under circumstances which require that they shall not be treated as paid or retired, they may be charged at par value to the appropriate Asset Account, but on the balance sheet statement they should be shown separately as a deduction from both the Assets and I iability Account in order that the Asset Accounts for securities owned will include only securities of other companies and that the Liability Accounts for securities issued or assumed will include only those in the hands of the public.

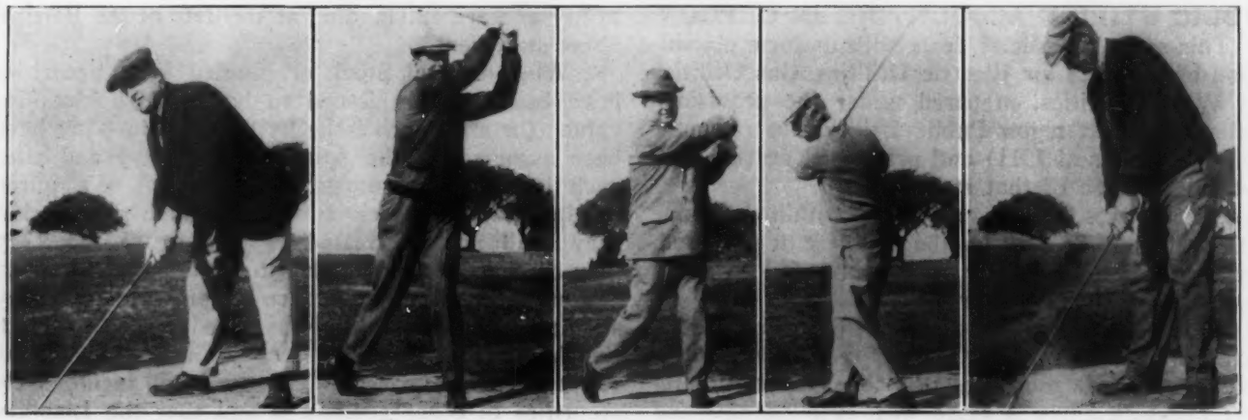
If any such securities are re-acquired for more or less than their par value, the difference between the par value and the cost of re-acquirement, after adjusting any amounts carried in the discount and premium accounts or other accounts with respect to such securities, should be debited or credited to Corporate Surplus of Deficit Account. Unless re-acquired for a sinking or other fund, which is required to be represented by a reserve, in which case the difference should be debited or credited to account, "Surplus Invested in Sinking Fund" or to account "Other Surplus Reserved" as may be appropriate.

4. **Discount and Premium on Capital Stock.**—Ledger Accounts should be provided to cover the discount and premiums on each class of capital stock issued or assumed by the utility. By "Discount" is meant excess of the par value of stock issued or assumed over the actual money value of the consideration received for such stock (except stock that has been sold and re-acquired); by "Premium" is meant the excess of the actual money value of the consideration received for stocks issued or assumed over the par value of such stock (except stock that has been sold and re-acquired).

Entries in these accounts representing discounts should be carried therein until offset: (1) by premiums realized on subsequent sales of the same class of stock; (2) by assessments levied on stock holders; (3) by appropriation of surplus for that purpose; or (4) by charges to corporate surplus or deficit account upon re-acquirement or retirement of stock. Entries in these accounts representing premiums realized, should be carried permanently, until offset: (1) By discount suffered on sales of the same class of stock; or (2) by credit to corporate surplus or deficit account upon re-acquirement or retirement of stock. If the net of the balances in the discount and premium account for all classes of capital stock sold or exchanged is a debit balance the amount should be included in the balance sheet statement in account, "Unextinguished Discount on Capital Stock"; if a credit balance, the amount should be shown in account, "Premium on Capital Stock."

In no case should discount on capital stock be charged to or included in any account as a part of the cost of acquiring any property, tangible or intangible, or as a part of the cost of operation.

[To be continued.]



## JOBBERS AT DEL MONTE.

Once again the Pacific Coast electrical jobbers and manufacturers have met in quarterly session "to chase the spheroid over the long green and also to be separated from some of the long green," to misquote a Wigginism. December 4, 5 and 6 at Del Monte gave full answer to the poet's query as to "What is so rare as a day in June?"

Golf was, of course, the all-absorbing subject. While the scores show that these electrical men can hit the ball, their pictures will raise the question "Is it form?" Whether caught in the act of a preliminary waggle, foozling, slicing, pulling or topping, none but a captious critic would deny that they showed great ability in addressing the ball, either orally or physically. Even the caddies, laden with driver, brassey, cleek, mashie, niblick and putter, confessed that they had never heard (of) such capable addressing.

The fascination of this game almost baffles description. Those who come to scoff at the game of golf soon their coats will doff and after the pill they're off.

Even "Kid" Murray now has more clubs than the law allows in any poker deck. He has not only cashed in his former enormous winnings at the latter game so as to buy golfers' paraphernalia, but also goes to bed at 10 o'clock so as not to spoil his golf. Whereas he was consoled with the high gross score at Gearhart, he was awarded the manufacturers' cup at Del Monte.

"Porch-climber" Wiggin, the inveterate fun-maker and veteran card sharp, also broke into the second story and came out on the roof with the contractor's cup. Benny Herr likewise foiled his opponents by winning a (tin) foiled cup. Colonel Carter will hold the Patton cup for low net score during the next three months, although most of the other honors were carried off by Fred Leggett, whose four cups show his prowess in calling "fore" on the fairway; these included not only the regular jobbers', Every Ready and Del Monte cups, but also a special cup given by the Hotel Del Monte for low gross score. The first two he will hold until the next meeting, while the others will be subject to the tax collector.

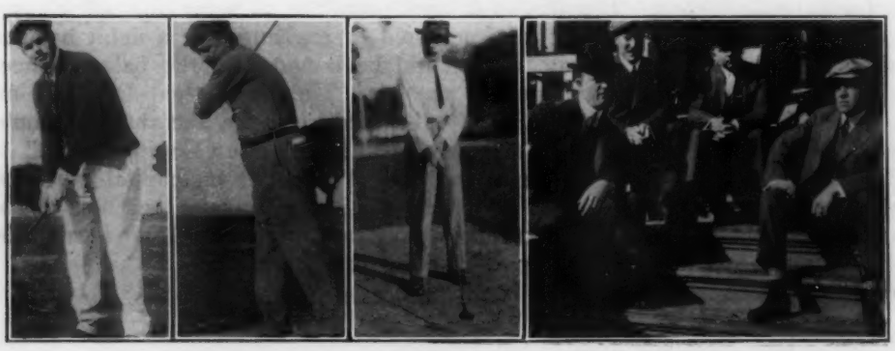
The following tabulations show the detailed results

**Jobbers' and Del Monte Cup.**

| | Gross. | Handi-cap. | Net. | Handi-cap. | Net. |
|---|---|---|---|---|---|
| Berry | 104 | +13 | 117 | 0 | 104 |
| Burger | 115 | — 1 | 114 | 0 | 115 |
| Brainard | 95 | + 7 | 102 | +7 | 102 |
| Carter, H. V. | 97 | + 6 | 103 | 0 | **97** |
| Carter, C. H. | 107 | + 2 | 109 | 0 | 107 |
| Elliott | 116 | — 6 | 110 | —6 | 110 |
| Goodwin | 109 | +13 | 124 | 9 | 109 |
| Graham | 127 | —12 | 115 | —12 | 115 |
| Hillis | 101 | + 8 | 109 | + 5 | 106 |
| Hall, C. B. | 114 | — 8 | 106 | —10 | 104 |
| Hartley | 115 | —16 | 129 | —16 | 129 |
| Leggett | **99** | 0 | **99** | 0 | **99** |
| Killam | 134 | —16 | 118 | —16 | 118 |
| Wiggin | **161** | —48 | 113 | —60 | 101 |

**Ever Ready, Contractors' and Del Monte Cups.**

| | Gross. | Handicap. | Net. |
|---|---|---|---|
| Berry | 110 | Scratch | 110 |
| Burger | 111 | Scratch | 111 |
| Brainard | 101 | + 7 | 108 |
| Carter, H. V. | 101 | + 7 | 108 |
| Carter, C. H. | 111 | Scratch | 111 |
| Elliott | 133 | — 6 | 127 |
| Goodwin | 109 | Scratch | 109 |
| Graham | ... | —12 | ... |
| Hillis | 105 | + 7 | 112 |
| Hall, C. B. | 121 | —15 | 106 |
| Hartley | No returns | —16 | ... |
| Leggett | 96 | Scratch | **96** |
| Killam | 137 | —16 | 127 |



**Manufacturers' Cup.**

| | Gross. | Handicap. | Net. |
|---|---|---|---|
| Barlow | 125 | —13 | 112 |
| Bibbins | 104 | + 4 | 108 |
| Collins | 142 | —18 | 124 |
| Gregory | 102 | — 1 | 101 |
| Herr | **153** | —18 | 135 |
| Hall, H. B. | 120 | —13 | 107 |
| Hyde | 121 | —15 | 106 |
| Lillard | 97 | +15 | 112 |
| Morris | 132 | 0 | 132 |
| Murray | 118 | —24 | **94** |
| Oakes | 112 | —10 | 102 |
| Poss | 125 | — 8 | 117 |
| Sanderson | 96 | +15 | 111 |
| Seaver | 125 | —18 | 107 |
| Squires | 126 | —18 | 108 |
| Steele | 125 | —24 | 101 |
| Vandegrift | 152 | —24 | 128 |
| Young | 125 | + 8 | 132 |

Other outdoor sports, such as tennis, swimming and tramping, occupied the other daylight hours, while a host of ordinary and extraordinary indoor sports accounted for the Mazda-light hours. Of the latter the only results which we are allowed to publish are those of the pool tournament, which was won by Harry Byrne, with John Cole second.

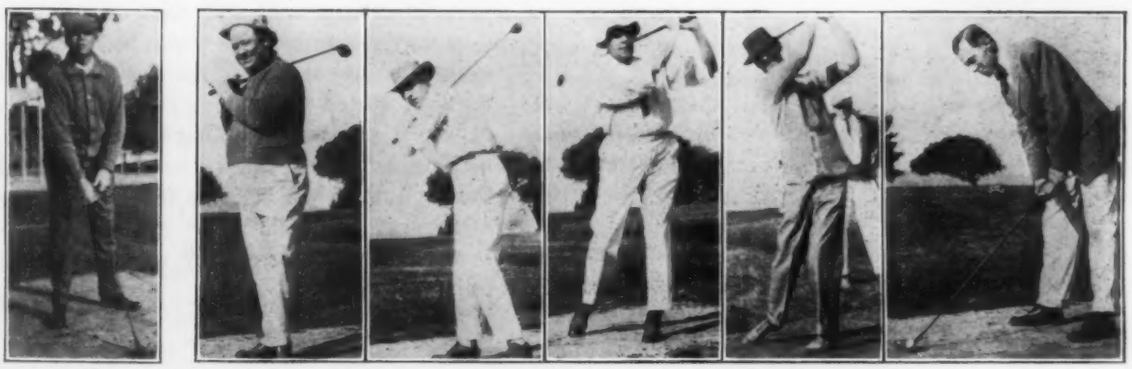
Saturday afternoon great enthusiasm was developed with regard to the Society for Electrical Development and on the understanding that a Pacific Coast office be established, every jobber present stated that his firm would give favorable consideration to joining this co-operative movement.

While these few business details were being settled, the ladies in the party played bridge, motored, rested and wandered around through the beautiful and historic surroundings with which this spot is blessed.

The regular golf dinner was held on Saturday night, and, as usual, was the occasion of much good-natured fun. C. C. Hillis presided as toastmaster and first saw to it that the individual who had W. B. Hall's goat returned it to him. The several cup-winners were called upon to tell how they did it, and W. L. Goodwin announced that arrangements had been perfected to the annual convention of the national association at Del Monte in 1915. Speeches were also made by H. V. Carter, A. H. Halloran and A. H. Elliott.

The following were in attendance:

Mr. and Mrs. C. H. Carter, Pacific States Electric Co., L. A.
Mr. and Mrs. C. C. Hillis, Electric Appliance Co., S. F.
Mr. and Mrs. F. H. Leggett, Western Electric Co., S. F.
Mr. and Mrs. H. V. Squires, H. V. Squires Co., San Francisco.
F. N. Averill, Fobes Supply Co., Portland, Ore.
A. E. Barlow, American Ever Ready Co., San Francisco.
W. S. Berry, Western Electric Co., San Francisco.
T. E. Bibbins, General Electric Co., San Francisco.
T. E. Blake, Hawaiian Electric Co., Honolulu, T. H.
H. B. Brainard, Western Electric Co., San Francisco.
T. E. Burger, Western Electric Co., Los Angeles.
Harry Byrne, North Coast Supply Co., Seattle, Wash.
H. V. Carter, Pacific States Electric Co., San Francisco.
Jno. R. Cole, John R. Cole Co., San Francisco.
T. E. Collins, Westinghouse Electric & Mfg. Co., S. F.
A. H. Elliott, Secretary, San Francisco.
W. L. Goodwin, Pacific States Electric Co., San Francisco.
M. W. Graham, Holabird-Reynolds Co., Los Angeles.
J. A. Greer, Rail Joint Co., New York.
S. B. Gregory, Arrow Electric Co., San Francisco.
C. B. Hall, Illinois Electric Co., Los Angeles.
W. B. Hall, Pass & Seymour, Inc., San Francisco.
A. H. Halloran, Journal of Electricity, Power & Gas, S. F.
Ross Hartley, Pacific States Electric Co., Los Angeles.
Jos. A. Herr, Sprague Electric Co., San Francisco.
R. D. Holabird, Holabird-Reynolds Co., San Francisco.
P. B. Hyde, Thos A. Edison, Inc., San Francisco.
F. N. Killam, Pacific States Electric Co., Seattle, Wash.
O. W. Lillard, Gould Storage Battery Co., San Francisco.
Jno. M. Morris, Westinghouse Elec. & Mfg. Co., Los Angeles.
F. H. Murray, National Carbon Co., Los Angeles.
A. H. Nylen, Gilson Electric Co., Oakland.
P. F. Oakes, American Ever Ready Co., San Francisco.
W. I. Otis, San Francisco.
F. H. Poss, Benjamin Electric & Mfg. Co., San Francisco.
W. R. Pounder, Hubbard & Co., San Francisco.
H. C. Rice, General Incandescent Lamp Co., Cleveland, Ohio.
H. E. Sanderson, Bryant Electric Co., San Francisco.
W. H. Seaver, American Steel & Wire Co., San Francisco.
M. F. Steele, Benjamin Electric & Mfg. Co., San Francisco.
J. A. Vandegrift, Oakland Lamp Works, Oakland.
C. E. Wiggin, Dunham, Carrigan & Hayden Co., S. F.
C. N. Will, Fobes Supply Co., Portland, Ore.
Garnett Young, Telephone & Elec. Equipment Co., S. F.



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**The South Yuba Development**

The true conservation of water power consists in its complete utilization. Probably nowhere in the West is this principle more completely demonstrated than in the South Yuba hydroelectric development of the Pacific Gas & Electric Company described in this issue, the Spaulding-Drum development, noted more particularly, completing a system which now conserves the entire runoff of a large watershed.

Man has mastered these waters without their knowledge; has furtively extracted their powers. All that he has done though, has been in accordance with its own law for the one thought of the water is hastening downwards. In its vertical fall of 5000 ft. this water is to be used seven times for power purposes. It finally finds its way into irrigation ditches, supplying moisture to over 70,000 acres of deciduous fruit lands which without this irrigation would be of much less value. Many towns and districts are also supplied with water for domestic purposes from this same project which is probably the most complete utilization of a watershed to be found anywhere.

The engineering feats accomplished would a few years ago have seemed impossible. Yet notwithstanding these and other great difficulties met, the project was completed on time. The six months' period of constructing the Lake Spaulding dam is infinitesimal compared with the magnitude of the task.

In this development the mountain, forest, river, earth, and sky have all been combined to be of cooperative service to city and field.

Had there been a clamour of all interests and the greatest pressure brought to bear that both the city and country might be adequately served in the equitable disposal of this wonderful gift of nature—the power of the waters' fall—no more complete and comprehensive development could have taken place. In the final disposition of this water the service of land reclamation alone which has opened up an extensive territory to settlement and productiveness is invaluable.

It is difficult to conceive of any state or municipal institution having undertaken over the period in which this development took place, so complete a conservation of water power upon so diversified a plan. The performance of this company produces a strong argument against exclusive ownership by municipalities of their hydroelectric plants.

Recently a public service commission ordered one company to reduce its rates in a large number of cities and towns. In rendering its decision the commission stated that these new rates were not to be regarded as a controlling precedent by companies owning individual plants, as they are unable to affect the economies which come from a large central generating system. This again, argues in favor of private ownership with the energy sold to the municipality in bulk.

Such efficiency of utilization is evidenced in this development. If revenue is to be produced from such sources, then by the greatest diversity of use individual charges will be proportionately lowered.

---

**Where Specialization Fails.**

A specialist is one who has devoted his interested efforts along a certain channel, so that no matter what he has studied or observed, it has all had some bearing upon this main idea; and although this specialization, which occasionally amounts to self-immolation in the interest of the idea, is the result of a desire to be of the greatest possible service to others, it yet contains a danger. That danger is super-specialization.

A wrong interpretation is sometimes placed upon the excellent advice to decide on one occupation, profession, or branch of industry, and then concentrate on the realization of your success along that line. It has been narrowed down to the idea of be a specialist and nothing else, no matter whether the heavens shower adversity or whether for some other reason there is temporarily no use for your specialized services.

This is super-specialization — the somewhat remarkable expression of excess in a sense of limitation.

It is as though the college graduate starting out in the world were to decide to accept no position except that which would call for the application of those ideas gained from past studies. But those ideas were not to be his stock in trade. The studies were but a tool-kit to teach him to think.

The sane specialist does not carry a mental limitator. He is thorough in all things—a man who thinks first; with whom to think is to act, and who acting, still searches for the better way.

The men who succeed are specialists. But the successful bank president did not always occupy that position. Of course not. The possibilities are that he had reached his prime before finance claimed his attention. Then came specialization.

That specialization which is limitation results also in a floating population. These specialists become fastidious about their occupations. They can do a certain thing best, and unless they are able to work at that, they leave the town or district, are next heard from in another state, and then the envelope bears a foreign postmark. This is uneconomical.

Failure to find employment may be due to a lack of completeness. Failure to fathom one's own powers; distortion due to too close observation—a lack of perspective; fear of the unknown. When the specialist's employment is gone he has lost an anchor to windward, but the possibilities are that he may now scour over wider seas and secure treasures greater than his fancy has heretofore conceived.

"As a progressive and evolving being," wrote James Allen, "man is where he is that he may learn that he may grow." In the mental make-up or ability of the specialist may be a lack which change of occupation will supply. Reference to the master minds of the day is unnecessary, for your own experience will have shown you that each circumstance of our lives contains a lesson which rightly mastered makes it possible for us to progress. The bank president is where he is because he has done this. In his experience the humble and perhaps uncongenial tasks mastered, have given way to those considered higher and better.

Be a specialist in that thing which lies nearest to hand, be thorough, and you will succeed. And incidentally, a specialist out of work is a specialist no longer. If he thinks he is, it may be that instead of striving for success through specialization, he is now specializing as a success. The attitude is ludicrous, and the results disastrous always.

Are you, once a specialist, now out of employment? Consider this view. "Thou art weighed in the balances and art found wanting." Do that thing which lies nearest to hand. Fulfill your need, and press on.

---

**Western Distributing Warehouses**

Every manufacturer, except at times when sales exceed output, is compelled to carry stocks that orders may be promptly filled in the interests of good service. Within a comparatively wide radius from the factory the results of this service are felt and appreciated. But where factories are located in the East, western customers are at a considerable disadvantage.

It is rarely the case that manufacturers can carry large local stocks with the necessary warehousemen, clerks and representatives and similarly where only a small margin of profit is allowed electrical jobbers as distributors, it is economically impossible for each and all to carry complete stocks of such appliances, fittings and so on.

There are many reasons for this, among which may be mentioned, uncertainty of demand, changes in styles which are often known to the manufacturer in advance but not to the jobber who may unfortunately buy heavily on passing lines—and so on.

Consigned stocks to jobbers, except where but one handles a line exclusively, may work a hardship on the manufacturer and jobber and result in a higher storage expense than the business warrants.

The most satisfactory solution to this problem is one which would appeal to purchasers in the West because of the promise of prompt delivery it contains, which would appeal to the jobber because more economical and to the manufacturer for the reason that it would tend to reduce the quantities of consigned stocks and at the same time proffer an improved service which would aid in the disposal of his product.

This would need the formation of an Electrical Manufacturers' Warehousing Association having warehouses in the principal distributing centers of the West, the idea being that these would be co-operative distributing points maintained by representative manuacturers from which all jobbers could draw their shelf stocks and large orders.

By such an arrangement, manufacturers, jobbers and purchasers would profit and many losses and annoyances now charged to poor deliveries would be eliminated.

# PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

**J. C. Garretson**, Fairbanks, Morse & Company, Portland, was in Seattle last week on business.

**J. Presbey**, Holophane Works of General Electric Company, is travelling throughout the state of Washington.

**T. H. McDonnell**, formerly of Vallejo, has joined the staff of the California Electric Construction Company.

**H. C. Reid**, Pacific Fire Extinguisher Company, San Francisco, left on Monday for a two weeks business trip to Portland.

**G. W. Bacon**, president Sierra & San Francisco Power Company, has returned to New York after a three weeks' visit to San Francisco.

**H. C. Goldrick**, Kellogg Switchboard & Supply Company, has returned to San Francisco from a trip to British Columbia and the Pacific Northwest.

**P. B. Hyde**, Edison Storage Battery Supply Company, San Francisco, has left for a trip through southern California and expects to be gone for two weeks.

**Elgin Stoddard**, vice-president Chas. C. Moore & Company, Engineers, Inc., San Francisco, recently visited the Portland and Seattle offices of the company.

**Rudolph W. Van Norden** was a guest at the semester banquet of the Stanford University Section A. I. E. E. last week and spoke briefly on engineering subjects.

**A. G. Griswold**, president A. G. Electric & Manufacturing Company, Seattle, has returned to the San Francisco office after a business trip throughout the Northwest.

**K. G. Dunn**, vice-president Westinghouse Machine Company, is at Los Angeles on business and expects to remain in the southern part of the state for about two weeks.

**E. C. Burkhart, Frank Somers** and **C. V. Schneider**, attended a meeting of the executive board of the California Electrical Contractors' Association this week at San Francisco.

**S. G. Hughes**, pioneer telephone man of Forest Grove, Oregon, who built his first switchboard 19 years ago and his own toll line into Portland, is still actively engaged in the telephone business.

**Henry T. Scott**, chairman of the board of directors of the Pacific Telephone & Telegraph Company, and President **George E. McFarland** of the same company, have left for New York on business.

**A. J. Orem** of Boston, Massachusetts, is in Salt Lake City for the purpose of inspecting various Western enterprises in which he is interested, and particularly the Salt Lake and Utah interurban electric railroad.

**Charles S. Northcutt**, manager San Joaquin division Sierra & San Francisco Power Company, who recently married Miss Mabel Wren of Modesto, Cal., has returned to Modesto, after a honeymoon trip through the Puget Sound district.

**S. Henry Barrablough**, professor of mechanical engineering, New South Wales University, is at San Francisco and is on his way to London on university business. He was a student formerly at Cornell University and expects to visit that institution on his way to England.

**J. E. Latta**, for the past two years an associate editor of the Electrical Review and Western Electrician, is now special agent of the Underwriters' Laboratories, Inc., at Chicago, Ill. Mr. Latta, who is a native of North Carolina, a graduate of the University of North Carolina and of the Graduate School of Harvard University, was technical editor of Electrocraft at the time that periodical was absorbed by the Electrical Review. He previously had considerable experience both in the manufacturing and operating ends of the electrical business.

**John A. Britton**, vice-president and general manager Pacific Gas & Electric Company, entertained a party of guests at the company's new power development at Lake Spaulding. Among those who attended were: **Victor Etienne** Jr., of Etienne Bros. Cyclops Iron Works; **F. Birdsall**, Union Iron Works; **Carl A. Heise**, Westinghouse Company; **Geo. L. Cameron**, Standard Portland Cement Company; **W. A. Doble**, Pelton Water Wheel Company; **William Schaw** and **J. A. Batcher**, of Schaw-Batcher Company; **W. W. Briggs**, Great Western Power Company; **H. H. Noble**, Northern California Power Company; **John D. McKee**, Mercantile Trust Company; **M. H. de Young, Judge Henry A. Melvin, Charles Sutro, H. L. Cory, Rudolph W. Van Norden, Frank G. Drum**, president of the Pacific Gas & Electric Company; **A. F. Hockenbeamer**, second vice-president and comptroller; **D. H. Foote**, secretary; **Frank B. Anderson, John Martin, C. O. G. Miller, John E. Drum**, directors; **Frank G. Baum**, chief engineer of the project; **R. J. Cantrell, P. M. Downing** and **F. S. Myrtle**, other officials of the company.

## MEETING NOTICES.

### Jovian League of Southern California.

The League held its regular meeting at Christopher's last Wednesday, with Mr. R. H. Manahan as chairman of the day. Mr. F. L. Woodman, president Los Angeles Harbor Commission, gave an interesting address on "The Harbor & Kilowatt." There was a good attendance. In fact the League has undergone a rejuvenation. The average weekly attendance during the month of November exceeded 100.

### Electrical Development and Jovian League.

The semi-annual meeting of the San Francisco Electrical Development and Jovian League, was held at Tait's Cafe last Tuesday. Reports of the various standing committees were received and the following officers elected: W. F. Neiman, president; C. A. Heise, vice-president; E. B. Strong, secretary-treasurer; P. C. Butte and Edw. Whaley, members executive committee. Addresses were made by the retiring and newly-elected presidents. Due to the holiday season the meeting stood adjourned until the second Tuesday in January.

### Utah Electric Club.

At the regular luncheon of the Utah Electric Club at the Commercial Club last Thursday, Frank A. West, director of the Experiment Station of the Agricultural College of Utah, delivered an intensely interesting talk on the subject of "Radioactivity." About fifty members were present.

H. T. Plumb of the General Electric Company was elected chairman for February and W. W. Torrence was appointed vice-chairman of the entertainment committee on account of the absence from the city of H. F. Holland, the chairman.

On account of the fact that on Wednesday, December 10th, all of the civic organizations of the city will celebrate Utah Products Day by a monster luncheon at the Commercial Club, the Electric Club voted to join in the observance, so that the next luncheon will be held on Wednesday instead of Thursday.

### Portland Sections, A. I. E. E. and N. E. L. A.

The third joint meeting of the above associations was held at the Hawthorne Building, Portland, on the evening of December 2, 1913, when O. B. Coldwell, general superintendent Portland Railway, Light & Power Company, read a short introductory paper on Recent Regulative Measures Affecting Public Utilities. The various measures were discussed and further explained by the following: H. R. Wakeman who dealt more particularly with the Proposed Joint Pole Agreement, for Portland, by W. H. Evans, who discussed General Regulations governing Overhead and Underground

Construction. The application of these was taken up by D. F. McGee, who was followed by B. C. Condit, who took up the question of Station and Substation Construction in the state of Washington. Just as the last speaker, W. D. Scott, was closing his remarks on Co-operation with the Railroad Commission of Oregon, four fake policemen arrived and arrested Mr. Coldwell who was immediately arraigned before a "Kangaroo" court which had been staged behind a curtain A burlesque charge was made against Mr. Coldwell, the final result being his acquittal. The 200 members present were then served with refreshments, consisting of pumpkin pie and apple cider.

## TRADE NOTES.

Raymond Spencer of Santa Barbara has secured the contract for wiring the new postoffice in that city.

The Edison Storage Battery Supply Company announces the removal of its San Francisco branch office to 441 Golden Gate avenue.

Newberry, Bendheim Electric Company, Los Angeles, were awarded the electrical contract on the San Francisco Auditorium for $16,500.

The electrical contract for the Physicians' Building, Sutter and Powell streets, San Francisco, has been awarded to the Butte Engineering & Electric Company for $4900.

The Kellogg Switchboard & Supply Company has secured an order for complete central office equipment for the Independent Telephone Company, Forest Grove, Oregon.

## NEW CATALOGUES.

Druid Glass is described and listed in a recent pamphlet issued by Holophane Works of G. E. Company, Cleveland, Ohio. Stonehenge is the name of the latest Holophane design, the design in which Druid glass will be supplied.

The department of commerce has issued the second edition of Circular No. 32, of the Bureau of Standards on Standard Regulations for Manufactured Gas & Gas Service. This bulletin supersedes the first edition of Circular No. 32 issued April 1, 1912.

The report of the National Electric Light Association committee on resuscitation from shock, being distributed by the association in bulletin form, contains information of considerable importance to the whole of the electrical industry on this subject.

The Illinois Electric Company, Los Angeles, Cal., have issued a new catologue (No. 21) containing approximately 1000 pp. listing the material available for distribution by them. The catalogue is said to be very complete and comprehensive and should prove a valuable book of reference to the trade.

The Quality of Surface Waters of California is the title of Water-Supply paper No. 237 by Walton, Van Winkle & F. M. Eaton, published by the department of the interior, Washington, D. C., and for free distribution. The report contains a large amount of information concerning the streams and lakes of California.

New Reflectors and How to Use Them is the title of a new bulletin issued by the Crouse-Hinds Company, Syracuse, New York, which is devoted to reflectors for use in roundhouses, steel mills, etc. The bulletin also contains instructions as to how and where the reflectors should be mounted to give maximum results.

The Ohio Brass Company, Mansfield, Ohio, are distributing a splendid booklet which illustrates and describes the construction details of thirty prominent catenary roads. Construction methods in general are also described and a specification blank for catenary construction is also included. It is a valuable booklet on this subject and a companion to the company's general catalogue which is also mailed on request.

The Chicago Pneumatic Tool Company, Chicago, Ill., has issued Bulletin No. 34-D on "Chicago Pneumatic" Corliss Compressors, Steam Driven; 32 pp. It presents the principal features of their compressors of standard design and for capacities from 1000 to 6000 cu. ft. per minute for all usual air or steam pressures condensing and non-condensing. Constructional and mechanical details are fully described and actual installations are also illustrated.

"Motor Driven Refrigerating & Ice Making Machinery" is the title of a publication (Section 3133) just issued by the Westinghouse Electric & Manufacturing Company. This pamphlet gives some exceedingly interesting information. including data on motor applications, together with actual kw.-hr consumption for different plants. Illustrations are shown of various installations and a curve is given showing the horsepower required for refrigerating machines of different capacities.

## NEWS OF THE CALIFORNIA RAILROAD COMMISSION.

The railroad commission rendered a decision granting authority to the California Telephone & Light Company to issue $100,000 of bonds and $50,000 of stock, the proceeds of which will be devoted to new construction and equipment, and refunding indebtedness.

A decision was rendered authorizing Mary E. Backus to sell a water system in Eagle Rock to the Eagle Rock Water Company for $7596 of stock.

Authority was granted the Los Verjela Land & Water Company to mortgage its property in Yuba county to the Bank of Rideout, Smith & Company of Oroville as security for a note of $25,000. The proceeds will be used for the construction of a dam on Dry Creek.

The company was also granted permission to issue $65,750 of stock for the purpose of paying off a loan and for extensions.

The Coachella Valley Ice & Electric Company applied for permission to issue $300,000 of bonds for the construction of electric distribution lines in and around Coachella and Imperial Valleys.

An adjustment was affected reducing freight rates on the Southern Pacific throughout the Sacramento Valley.

## BOOK REVIEWS.

**Light Radiation and Illumination,** translated from the German of Paul Hogner by Justus Eck; 88 pp.; 5½x9 in.; cloth bound. Published by D. Van Nostrand Company, and for sale by the Technical Book Shop, Rialto Bldg.; San Francisco. Price $2.50.

This book is intended to assist electrical engineers, architects, central station salesmen, and others in planning lighting installations, and deals especially with the problems arising in connection with arc lighting. The problem of street lighting is dealt with in considerable detail and new methods are given for the calculation of street and surface illumination. The book gives rules and practical information that will enable good and reliable results to be secured and is an invaluable addition to the works relating to the engineering of illumination.

**Electrical Engineering.** By Clarence V. Christie, M. A. B. Sc.; 417 pp.; 6x9½ in.; cloth bound, and contains 377 diagrams. Published by McGraw-Hill Book Company, New York, and for sale by Technical Book Shop, Rialto Bldg., San Francisco. Price $4.

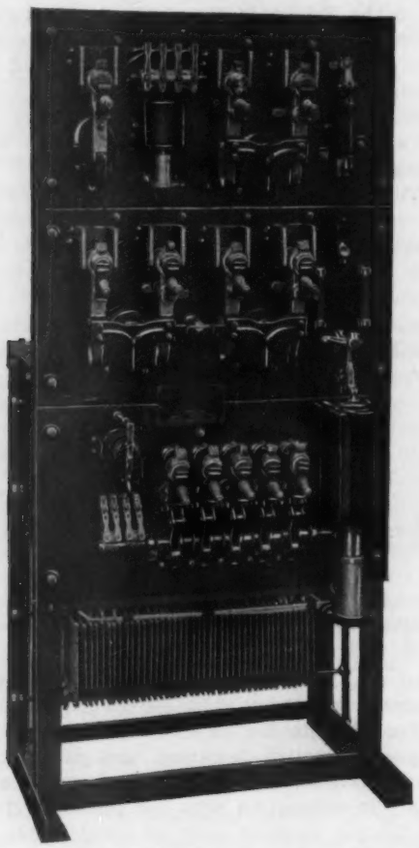
In this work the theory and characteristics of electrical machines are developed from the fundamental principles of electro-statics and electro-magnetics. There are chapters on electric circuits, direct current machinery, synchronous machinery, alternators and synchronous motors, transformers, induction motors, alternating current commutator motors, converters and the transmission line, and each is very thoroughly discussed. It was originally compiled as a foundation for lecture courses for junior and senior students in electrical engineering.

# INDUSTRIAL

## ELEVATOR CONTROLLERS THAT INSURE SAFETY.

In the design of Bulletin 7560 type full magnetic elevator controller the control system is laid out so that even should grounds or short circuits occur in the cables or switches, no damage to the elevator or its occupants can result. Failure of any part of the equipment to function properly results in the slowing down of the elevator and bringing it to a stop. The latest design of controller, the panel of which is shown in the accompanying illustration permits of all the refinements of control that can be used in connection with direct current motors.

These standard controllers, built by the Cutler-Hammer Manufacturing Company, Milwaukee, are furnished in either



Cutler-Hammer Magnetic Elevator Controller.

"single speed" or "two speed" types, both types being equipped with the slow-down feature. The single speed types are used with motors that have no field control. The two-speed controllers are used with motors having additional speed variation by means of shunt field resistance. The slow-down feature is obtained in both cases by means of the combination of armature series and shunt resistances. The armature shunt resistance is used also for dynamic braking.

The magnetic switches mounted on the slate control panel are simple and rugged in construction, and can easily be taken apart for inspection or for renewal of the contacts. All switch arms have a channel section, and other parts are heavily ribbed where required so as to eliminate the breakage of any of these parts.

All electrical contacts on these panels are "butt" type, carbon to copper. These contacts have a wide range of adjustment for taking up wear, thus insuring maximum life. Dust and dirt cannot collect on the contacts, because they are vertical.

The main contacts are equipped with magnetic blow-outs, the blow-out coil being of bar wound copper, mounted on the back of the control panel, so that these coils cannot burn out nor be damaged from the arc itself. All of the wiring is exposed on the back of the panel, and all terminals are accessible.

A double-pole main line switch breaks both sides of the line, and in connection with the direction switches gives four breaks in the armature circuit. The direction switches are mechanically interlocked to prevent their simultaneous operation, which would cause a short circuit on the line. These switches will automatically open on abnormal drop in voltage and stop the equipment.

A double coil overload movement is arranged to stop the elevator in case of overload, and can be automatically reset by throwing the car switch to the off position. This gives a reliable indication as to whether the car is overloaded and by having the resetting feature in the car switch, it is possible to set this overload within the closest limits. This device therefore possesses an advantage over the hand-operated circuit-breaker in that the operator is not compelled to go to the switchboard in case a slight overload occurs. The only thing necessary is to lighten the load on the elevator. With a manually operated circuit-breaker the operator, under these conditions, invariably increases the current setting of the breaker when he goes to the panel to reset it, and, in case of continued tripping, eventually ties the breaker in, thus eliminating the overload protection which the circuit-breaker is designed to give. Besides the main controller panel and the car switch, all the electrical accessories required for the control of electric elevators are made by the Cutler-Hammer Manufacturing Company.

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## WESTINGHOUSE MACHINE COMPANY.

At a recent meeting of the executive committee of the Westinghouse Machine Company an appropriation of $125,000 was made to provide additional manufacturing facilities required to take care of the rapidly increasing business which has been enjoyed recently, owing in a large measure to the new lines of products developed, and particularly the following: The impulse turbine which is being used by central stations, railways and industrial plants; the reduction gear, which in addition to the demand for marine installation, is finding a wide field of application in connection with large direct current generators. The gear is interposed between the high speed of the turbine and the low speed of the direct current machine with its commutator. Orders for automobile rotary valve motors have also contributed to increasing need for additional equipment.

The department manufacturing air springs for automobile trucks has also felt the influence of increased business. These air springs are interposed between the chassis and the body of the truck and materially reduce the jar and vibration. They have proved exceedingly popular for this class of vehicle. The company contemplates devoting a portion of the appropriation to securing additional machine tools designed to use high-speed tool steel, fully realizing their advantages, and thus adding to the already well equipped shop which this company now has in operation.

# NEWS NOTES

## FINANCIAL.

LOS ANGELES, CAL.—The Huntington interests in Los Angeles have contracted for the placing of a bond issue of $14,000,000 for extensions and development work in Southern California. The proceeds of the issue will be allotted to the Pacific Light & Power Corporation, the Los Angeles Railway Company and the Huntington Land Company. The Los Angeles Railway Company is to absorb the City Railway Company, which was organized about three years ago to provide for the extensions which were forced upon the city lines at that time.

SALT LAKE CITY, UTAH.—A well-founded statement is in circulation that the Utah Power & Light Company has acquired the $1,350,000 bonds and practically all the $1,000,000 stock of the San Juan Water & Power Company of Colorado. The deal takes with it the control of the Durango Gas & Electric Company. The San Juan Water & Power Company owns and operates several plants on the Animas River near the Denver & Rio Grande Company, in southwestern Colorado. It was owned by interests identified with the Colorado Power Company, with headquarters in Denver. The acquisition of the San Juan company is understood to be a step toward the formation of another big combination of power concerns in Colorado. It will be turned over to the Western Colorado Power Company, which was incorporated last March with $5,000,000 capital. The Western Colorado Power Company has already acquired all the power plants in this state, formerly owned by the Telluride Power Company, which were sold last December to the Utah Power & Light Company.

## INCORPORATIONS.

OAKLAND, CAL.—Articles of incorporation of the Hayward Water Company have been filed with the county clerk. The recited purpose of the corporation is to furnish water to towns and cities. The concern is capitalized for $200,000, divided into 2000 shares with a par value of $100. Platt Kent of San Francisco, Oscar Sutro of Piedmont and C. Ramsey of Oakland are directors.

LOS ANGELES, CAL.—The Los Angeles Railway Corporation and the City Railway of Los Angeles, have filed articles of incorporation here and with the secretary of state at Sacramento, providing for the consolidation under the name of the Los Angeles Railway Company. Under reorganization, with W. E. Dunn, C. A. Henderson, G. E. Ward, S. W. Haskins, J. E. Brown, Frank Griffith and Albert Crutcher as incorporators, $5,000,000 of stock of the two former companies will be wiped out and the new company capitalized at $20,000,000. The new company will issue bonds in the sum of $23,500,000 to cover the indebtedness and $26,500,000 to build tunnels and make other improvements.

SALT LAKE CITY, UTAH.—The Salt Lake Terminal Company, organized to construct and operate a union terminal for the Salt Lake and Ogden Railroads, commonly called the Bamberger line, and the Salt Lake & Utah Railway Company, the new line which the Orems are building south from Salt Lake City, has recently filed articles of incorporation. The company is capitalized at $1,000,000. Julian Bamberger, president; J. H. Devine, vice-president; F. M. Orem, secretary and treasurer, and J. B. Bean, Henry I. Moore and W. R. Armstrong are the incorporators and directors. The company has acquired property in the blocks between Second and Third South and Main and Second West at a cost of $150,000, which will be utilized for the erection of the necessary terminal buildings.

## ILLUMINATION.

SEATTLE, WASH.—The contract for ornamental street lighting has been let to H. G. Behneman for $2,032.16.

SAFFORD, ARIZ.—The Gila Valley Electric, Gas & Water Company is busy on a proposition of securing a complete up-to-date electric light plant for this town.

LOS ANGELES, CAL.—Sealed bids will be received up to December 22d, by the board of supervisors of Los Angeles county, for installing and maintaining additions to the street lighting system in Westgate Lighting District.

SACRAMENTO, CAL.—Action has been taken by the city council to compel the property owners west of Fourth street between I and M streets, who have not so far installed electroliers to do so. The work will cost about $9691.

SAN JOSE, CAL.—Application has been made by the Pacific Gas & Electric Company for a franchise for the transmitting of electricity in the town of Alviso. Sealed bids will be received up to January 5, 1914 for the sale of the franchise to the highest bidder.

RAYMOND, WASH.—Henry W. Urquhart of Chehalis and John Stewart of Seattle have filed their written acceptance with the city of Raymond of the franchise granted them recently to supply gas to the city. The time limit set in the franchise for installing their plant is 18 months.

LOS ANGELES, CAL.—The city council, by a vote of 5 to 3, ousted President McReynolds of the board of public utilities, thus making operative Mayor Rose's order of removal. Following this, Mr. A. W. Wright resigned, setting forth his reasons that he was jointly responsible with Mr. McReynolds for the gas controversy. The third member of the board, Mr. Martin Bekins, is in New York.

RIVERSIDE, CAL.—The city council has authorized the mayor to enter into a contract with the Pacific Light & Power Company, revocable at pleasure of the board, to operate and maintain a pole line from Santa Ana River running over private property to Jurupa avenue, near the junction of Jurupa and the Salt Lake Railroad to New Magnolia avenue, and the right to operate a three-wire circuit on a pole line of the Pacific Electric.

HELENA, MONT.—The public service commission of Montana has ordered the Montana Power Company to reduce its rates in the thirty-one cities and towns in which it operates. The reductions vary from 12 per cent to 50 per cent. The commission in rendering this decision, states that these rates are not to be regarded as a controlling precedent by companies served by individual plants, which because of their separate organization are not able to effect the economies that come from a combined management such as is furnished by the Montana Power Company.

## TRANSMISSION.

SUSANVILLE, CAL.—The Lassen Electric Company has been granted a franchise to construct and operate poles, towers and others super-structures for transmitting electricity in the county of Lassen.

LAS VEGAS, NEV.—An order has been issued by Secretary Lane, with the president's approval, creating a power site reserve in Boulder canyon, on the Colorado River, 20 miles east of this city. It is expected the construction will develop 40,000 h.p. at a minimum of expense.

SAN FRANCISCO, CAL.—N. W. Halsey & Company, and N. W. Harris & Company have purchased from the Pacific Gas & Electric Company an additional block of $500,000 of the 6 per cent secured gold notes of that company, dated July 1, 1913, due June 25, 1914, which is additional to $4,500,000 heretofore purchased and distributed by the same houses. The generating capacity of the company's plants at the present time is 312,493 h.p., which includes the first unit of the Lake Spaulding development now in successful operation.

SEATTLE, WASH.—Submission of a bond issue of $250,000 in order to provide funds for the acquirement by condemnation of the Lake Cushman power site is proposed by Councilman Oliver T. Erickson. The bill providing for the condemnation of the site was introduced some time ago. It is proposed to condemn several thousand acres of land around Lake Cushman, using the lake as an impounding reservoir. The plan calls for the construction of a dam across Skokomish River and the entire undertaking is estimated to cost between $5,000,000 and $6,000,000.

LOS ANGELES, CAL.—The failure of some bolts in an expansion joint, at the Big Creek plant of the Pacific Light & Power Corporation, allowed the penstock to open about 300 ft. above the power house, and service was interrupted. Repairs have been made and no great inconvenience was experienced. Arrangements are being made to deliver the full load capacity of the present development. During the break a few days ago, which put the upper plant out of commission for a brief period, one of the units in the lower plant was started up and relieved the situation temporarily. Two 20,000 h.p. units at each station will be in service in a few days. It is proposed to operate at 135,000 volts until the second transmission line to Los Angeles is completed.

LOS ANGELES, CAL.—Terms under which the Aqueduct will be transferred from the board of public works to the board of public service have been practically agreed upon, and the council is prepared to take action, making the transfer complete. According to the agreement, the board of public service will take over the salvage on the Aqueduct construction, which has been roughly appraised at $1,400,000, and will assume the obligations of the board of public works. These obligations amount to approximately $445,000, including a loan of $236,000, made by the water department to the Aqueduct Bureau. The proceeds from the salvage will be used by the board of public service for further construction work on the Aqueduct. It has not been determined yet, which board shall have control of the Aqueduct Power Bureau.

SALT LAKE CITY, UTAH.—January first is the date set by the Utah Power & Light Company for the delivery of the first electric power from its new plant, Bear River, Grace, Idaho. It is expected that the new eleven-foot pipe line which conveys the water from a point 23,000 ft. up the river to the plant will be ready for delivery of water to the turbines at that time. This new plant will develop 33,000 h.p. The power house is 45 ft. wide and 156 ft. long. This power and that developed by the present plant at Grace will be transmitted directly to the company's new substation, about three miles west of Salt Lake City by means of a 135-mile steel tower line, from which point it will be distributed to the Utah Light & Railway Company, who purchase a large block of power from the company, to Bingham and Garfield, where large quantities of power are used by the copper mines and smelters, and to the suburban territory served by the Utah Power & Light Company.

REEDSPORT, ORE.—The department of agriculture has issued a permit to Jas. Lindsey of Portland, Oregon, for the operation of a power plant on Mill Creek, Douglas county, Oregon, within the boundaries of the Linslaw national forest. The power will be transmitted at 22,000 volts to Reedsport, a distance of 18 miles, where it will be used in the manufacture of pulp. Besides, the power plant and pulp mill, other industries are contemplated. In connection with the power development a rock-fill dam about 30 ft. in height and 126 ft. maximum length is to be constructed at the outlet of Loon Lake, which has an area of 265 acres. By providing a depth of 20 ft. between the surface and the outlet pipe, storage of about 4800 acre ft. will be obtained. The conduit is to have a total length of four-fifths of a mile, the greater portion of which is to be wood-stave pipe 5 ft. in diameter. The power house is to be constructed with a concrete foundation, timber frame and sheet iron covering. There will be installed three 1150 h.p., horizontal, Francis-type turbines, acting under a head of 263 ft., these being direct-connected to three 750 k.v.a., 3-phase, alternating-current generators.

## TRANSPORTATION.

LOS ANGELES, CAL.—Plans are being made by the Pacific Electric Railway to install a $20,000 inter-locking plant at the crossing of the Santa Fe near Cucamonga. The state railroad commission has agreed to the installation.

CLOVIS, CAL.—An application has been made to the board of trustees by F. S. Granger for a franchise to construct and operate an interurban electric railway in this city. Sealed bids will be received up to January 5th for the sale of the franchise.

TACOMA, WASH.—The Oregon-Washington Railway & Navigation Company will construct two new lines next year, one to Olympia and the other to South Bend and Raymond in the Willapa harbor district. It is estimated that this work will cost $5,000,000.

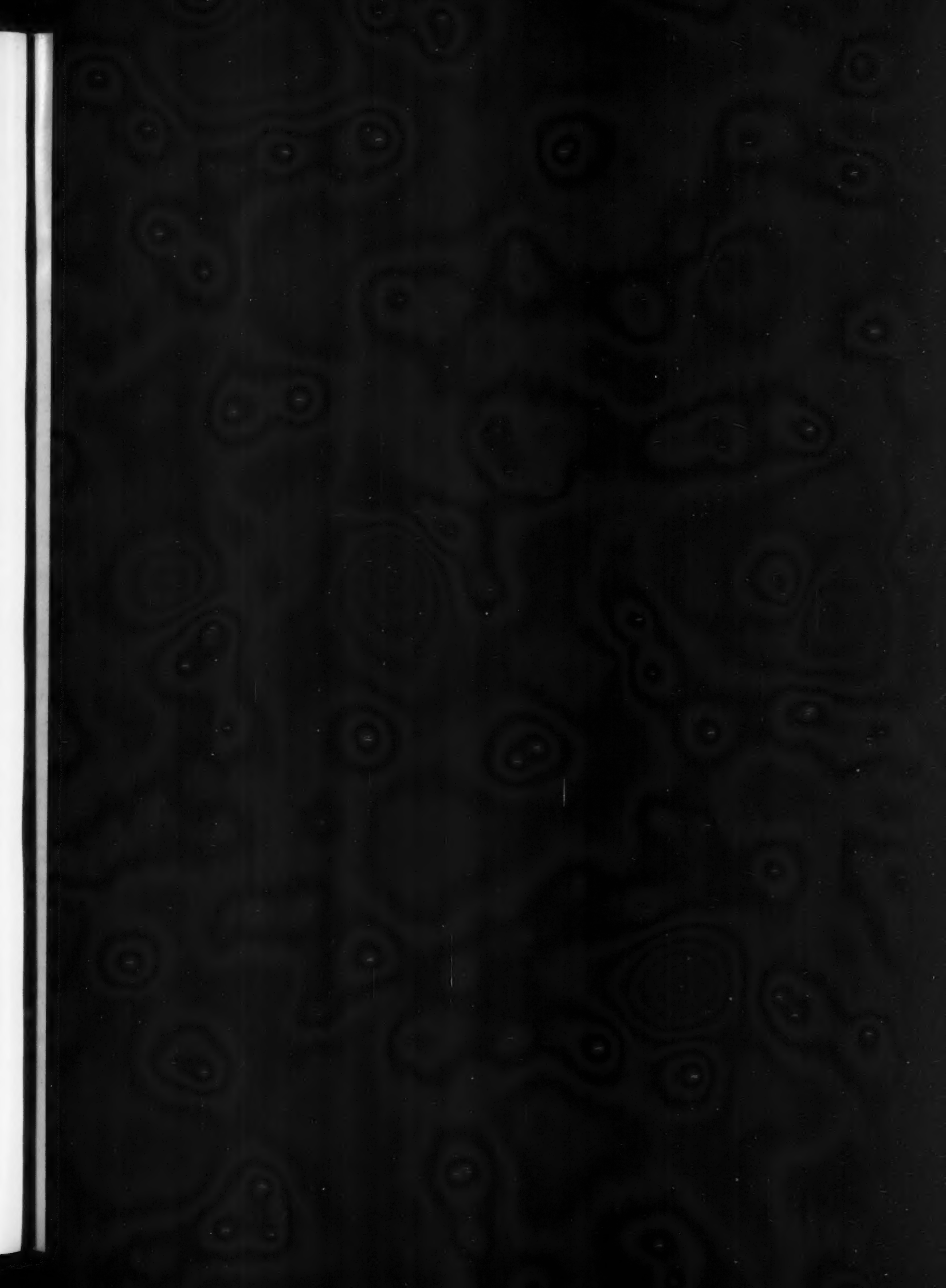
PORTLAND, ORE.—On the ground that the recently passed six-for-a-quarter fare ordinance violates the Federal Constitution, the Portland Railway, Light & Power Company has obtained a temporary injunction restraining the city from enforcing the ordinance. The order was granted in the federal court. It was contended that the public utilities law placed the jurisdiction of fares in the hands of the state commission.

TWIN FALLS, IDAHO.—December first marked the completion of the first four miles of the new electric storage battery railway being constructed by I. B. Perrine to the Great Shoshone Falls. The event was celebrated by the public schools of this city in recognition of the fact that commencing on that day the school children living along the route will be transported to the city schools by the electric trolley car pending the completion of the line and its opening for regular operation.

## TELEPHONE AND TELEGRAPH.

CENTRALIA, WASH.—A franchise has been granted by the Lewis county commissioners to the Salzor Valley Telephone Company for a line up Salzer Valley east of Centralia.

PORTLAND, ORE.—The railroad commission has ruled that the Pacific Telephone & Telegraph Company must connect their trunk lines onto a switchboard supplied to a subscriber—the Oregon Hotel, by the Home Telephone Company.

SEATTLE, WASH.—Richland Valley farmers have organized a country telephone system called the Yakima & Columbia River Telephone Company. It will probably be incorporated for $2500. The officers are: E. E. Floyd, president; J. R. Gardener, vice-president; Wm. Reed, secretary.

TUCSON, ARIZ.—C. H. Gaunt, general manager of the Pacific division of the Western Union Company, states that a large sum of money is to be expended in the improvement of facilities in the Western Union office at Tucson. The main trunk lines to Chicago are to be supplemented with further wires, and many smaller improvements are to be made.